THURSDAY, APRIL 22, 1886

INJURIOUS INSECTS

Reports on Insects Injurious to Hop Plants, Corn Crops, and Fruit Crops in Great Britain. Prepared for the Agricultural Department, Privy Council Office, by Charles Whitehead, F.L.S., F.G.S. No. II., "Insects Injurious to Corn, Grass, Pea, Bean, and Clover Crops." (1885.)

Reports of Observations of Injurious Insects and Common Farm Pests during the Year 1885, *with Methods of Prevention and Remedy.* By Eleanor A. Ormerod, F.R.Met.Soc., &c. (London: Simpkin, Marshall, and Co., 1886.)

THE first of these works, a Government Report issuing from the press of Messrs. Eyre and Spottiswoode, and bearing the announcement that it was "Presented to both Houses of Parliament by command of Her Majesty," forms the second of the series, and is a very valuable contribution to the knowledge of the insects destructive to crops mentioned above. It will be of great service to agriculturists, whether scientific or otherwise, as the whole Report from beginning to end is written in a clear and concise manner, without losing any of its accuracy. The Report occupies seventy pages, and of these, forty-nine pages are devoted to "Insects injurious to corn and grass crops." From p. 50 to 56 "Insects injurious to corn in store" are treated of, and from p. 57 to the end "Insects injurious to pea, bean, and clover crops" are dealt with. Each insect has a separate article devoted to it, uniformly treating first of the habits of the creature, the manner and extent of its devastations, then under separate heads the life-history is given, prevention, and remedies.

The crane-fly, or more popularly the daddy-long-legs (*Tipula oleracea*, L.), comes in for a considerable share of attention. Mr. Whitehead reminds us that "It is the larvæ or grubs that injure plants of corn and grass, by attacking them with their strong jaws and eating into them just beneath the surface of the ground, so as either to kill them or make them weak and sickly. In the early spring, if wheat plants which show signs of failing are examined, large ash-grey grubs or maggots will often be found close to the affected plants. Oats and barley are equally liable to harm from these grubs, not perhaps quite to such an extent as autumn-sown wheat, and especially wheat sown after clover leys."

Mr. Whitehead gives the following estimate of loss occasioned by these insects:—"A field of oats sown on March 1, after clover, was attacked by these grubs. Although it was an even strong plant, it was soon nearly half devoured, and, instead of nine quarters per acre being obtained, as might have been expected from the state of the land, and the circumstances of its cultivation, and the produce of other land hard by, only about four quarters per acre were grown. It is computed that the loss in this case amounted to 80*l*." As an illustration of Mr. Whitehead's manner of treating the life-history of the several insects, the following quotation from that of the daddy-long-legs will suffice:—"The life-history of the crane-flies, both of the *Tipula oleracea* and its close congener *Tipula maculosa*, is simple. The eggs are small, oval, conical grains, shining and black as ebony (as Curtis writes), forming a mass which occupies nearly the whole of the abdomen. As many as 300 have been found in one female. These are deposited, in the autumn, upon grass and herbage, and more frequently in the ground. Wet, undrained meadows and marshy and damp places are preferred by these insects, and the conditions of such spots are probably favourable to the preservation and the ultimate hatching of the eggs. This hatching takes place in the early spring, directly the weather becomes mild. . . . After hatching, the maggots or larvæ grow fast until they become an inch in length. Labourers call them 'leather jackets' because of their tough skins. Their colour is of the earth, with a slight dash of grey or ash colour in it. Although they have no legs, they are able to move rapidly from place to place, and burrow in the ground. It is in this grub form that they do mischief to crops, and they remain in this stage of their existence until the beginning of July, at which period they change into pupæ under the surface of the soil. After a while the pupæ work their way up to the light by means of hooks or recurved spines, and in a short time the crane-flies appear, and soon unfold their long wings and fly away to commence a new series."

After some further notes descriptive of the insects, some instructions are given under the heads of Prevention and Remedies.

It will be seen that the mode of imparting information is of the simplest and clearest description, and in this as well as in the manner of treatment the author has followed Miss Ormerod in her well-known manual, and moreover he frequently quotes her views and opinions expressed throughout her valued reports.

Just as we are finishing this notice Miss Ormerod's ninth annual "Report of Observations of Injurious Insects and Common Farm Pests during the Year 1885, with Methods of Prevention and Remedy," comes to hand. Like its predecessors, it is full of interesting and valuable records. Miss Ormerod has still something more to say on that general pest referred to above—the daddy-long-legs. It is, perhaps, not generally known how difficult the grubs are to kill, but Miss Ormerod's experiments, as recorded in a previous Report, proved that they could endure almost any amount of freezing and yet come to life as the season returned. Speaking of the grubs, one correspondent, in the Report before us, says:—"In my experience, any chemicals applied for their destruction when they begin to make their ravages must destroy the grain. I have had them covered with salt and soot over night, and they have been alive in the morning." Miss Ormerod here notes that "This observation quite agrees with the result of the experiments of Mr. Ralph Lowe (noted p. 26 of Report for 1884), in which grubs covered respectively with quicklime, soot, household salt, and superphosphate, and also some placed in earth mixed with one-fourth of white arsenic, were not at all the worse, excepting those that had been in the arsenic, and even these recovered before the following day. But nitrate of soda had much more serviceable effects."

It is satisfactory to find that the cases of injurious insects which were exhibited for so long a time in the Bethnal Green Museum are being thoroughly overhauled.

Miss Ormerod remarks in the preface to her Report that the rearrangement of these cases, in which are shown insects injurious to crops, fruit, and timber, is now in progress, and promises to be of practical service. "The insects exhibited are for the most part those which are serious in their ravages, and, as far as is possible, they are shown in their various stages (either by specimens, drawings, or models), with samples of injury caused by them accompanying."

Appended to the Report are some special observations on the warble-fly or ox-bot-fly.

ACROSS THE JORDAN

Across the Jordan: Being an Exploration and Survey of Part of Hauran and Jaulan. By Gottlieb Schumacher, C.E. With Additions by Laurence Oliphant and Guy Le Strange. (London: R. Bentley and Son, 1886.)

THIS volume is the last of several recently published by the Committee of the Palestine Exploration Fund, following quickly on the steps of Conder's "Heth and Moab" and Hull's "Mount Seir," and describes with great accuracy a district lying to the east of the Sea of Galilee not often visited; or, if visited, only hastily skirted, by travellers on the road from Jerusalem to Damascus. How little is known of its geographical details may be gathered from a comparison of the excellent map which faces the title-page of the book with any of the best maps now published. The district described embraces the eastern part of the Jaulan and the western of the Hauran, and is remarkable for the number and variety of its works of ancient art, dating from the time of the dolmen-builders to those of the Crusaders, and including structures referable to Jewish, Greek, Roman, and Christian times. How this region came to be explored is narrated by Mr. Walter Besant in the preface. It appears that about a year ago a firman was granted by the Porte for the survey of the district lying between Haifa on the Mediterranean and Damascus, with a view to the construction of a railway. For the western part of this route, namely, that between Haifa and the Jordan Valley, the maps of the Palestine Exploration Society afforded the necessary details; but from the Jordan to Damascus the line of country had to be specially surveyed, and this work was intrusted by the *concessionnaires* to Herr Gottlieb Schumacher. In the course of his work Herr Schumacher was able to make many scientific observations, as well as maps and drawings of villages, structures, and works of art, which he afterwards embodied in the memoir forming the greater part of the present volume. A ready means of publication was found in the active Society which has done so much in elucidating, and embodying in maps and memoirs, the topographical details of Palestine and its borders.

To the geologist, as well as to the antiquarian, the region of the Jaulan and Hauran is full of interest, and the author has added some details on its geological structure which are very acceptable. The best and most recent observations on this subject are those of Prof. L. Lartet, and contained in his work on the geology of the Dead Sea.[1] The country, as is well known, is volcanic, and is largely covered by sheets of basalt, scoriæ, and ashes which have been erupted from numerous vents, some of which lie in the district here described. Several of these, such as Tell-ej-Jabiyeh and Tell-ej-Jemû'ah, reach an elevation of considerably over 2000 feet above the Mediterranean, and therefore of nearly 3000 feet above the surface of the Sea of Galilee. The southern margin of the Jaulan region, as well as of the basaltic formation, is marked by the deep gorge of the Yarmûk (Hieromax of Pliny), to the south of which the soft *Cretaceo-Nummulitic* limestones reach the surface and afford a genial soil to forests of oak. The Yarmûk receives several tributaries from the north, now correctly mapped for the first time, which lay open on their banks fine sections both of the volcanic rocks and of the underlying chalky limestones; and these streams, which are large and swift, are often precipitated over cliffs of basalt, forming fine cascades. One of these in the Wady Seisûn, a tributary of the Rukkad, has a fall of 100 feet, and then, pursuing its course by a succession of cataracts, unites with the larger stream after falling 517 feet in 420 yards. The Rukkad rises at the foot of Mount Hermon Jebel-esh-Sheikh), a little above the village of 'Ain-el-Berbab, and, upon the melting of the snows in early summer, sends a large flood of water into the Yarmûk It is remarkable, however, that none of these streams depend altogether on surface drainage for their permanent supplies, as they have their sources in springs; and the combined volume of these waters goes to form a river of equal volume with that of the Jordan itself where it leaves the Lake of Galilee. There are clear indications of the existence of large underground reservoirs of water in the basaltic and calcareous formations. The winter snows and "the former and latter rains" of autumn and spring rapidly sink into the fissured and broken strata, and are pent up, either in the mass of the rock itself, or in caverns which have been formed in the limestone by the solvent action of percolating water. These waters probably accumulate under the tracts sloping towards the south from the base of Hermon to the north of the Yarmûk Valley, and when a vent is formed rise to the surface with force. One of these springs, that of Râs-el-'Ain at the village of El Mezeirîh, fills a considerable basin, and is two to three yards across and about two feet deep at its source; others are of nearly equal copiousness and more or less thermal.

The physical phenomena connected with the district described by Herr Schumacher have their counterpart in the volcanic district of Central France, with this exception, that there do not appear to be any examples of the highly silicated class of lavas, such as domite, trachyte, &c., which we generally find associated with the basic varieties. As regards the geological age of the volcanic outbursts, the question is brought within narrow limits by their relations to the Cretaceo-Eocene limestones. Both these formations appear to have been not only deposited, but subsequently upraised and largely denuded, before the volcanic lavas issued forth from their subterranean reservoirs. As this movement and denudation of the strata took place in the Miocene epoch, the volcanic eruptions may be referred, with little uncertainty, in the main to the succeeding Pliocene; an epoch remarkable for outbreaks of vulcanicity over large portions of the globe. At

[1] "Voyage d'Exploration à la Mer Morte," par M. le Duc de Luynes; tome 3me, "Géologie" (Paris).

the same time it is not improbable that the first outbursts may be dated back to the later Eocene, and the last to the period when the waters of the great Jordan-Valley Lake had receded from their original limits to those within which they are now restricted.

The physical details form but a small part of the volume, which contains a large number of carefully drawn figures of works of art and architecture, accompanied by descriptive text, showing that the region, now the abode of Fellahin—or of migratory Arabs—was one of importance during long centuries of successive dynasties and races. The book cannot fail to be of value to students of Biblical and ancient history, and we are promised by Herr Schumacher descriptive drawings and maps of another section of the Hauran country.

HARBOURS

The Design and Construction of Harbours. A Treatise on Maritime Engineering. By Thomas Stevenson, P.R.S.E., &c. Third Edition. Pp. xiv. + 355. Twenty-four Plates. (Edinburgh: A. and C. Black, 1886.)

THIS work is a reprint, with large and valuable additions, of the article "Harbours" in the Encyclopædia Britannica." Its importance may be gauged from its acceptance in successive editions of that "Encyclopædia, and from its having passed into three editions in the separate and enlarged form.

An important feature is the attempt to lay down general principles, and to discuss and reduce as far as possible to calculation the effect of the great forces of wind and water, and to regulate both the general design and the details of constructions thereon. To the earlier engineers this was mere guesswork, *e.g.* Smeaton is said (p. 41) to have described these forces as "subject to no calculation." Many striking instances of the maximum effect of wind and waves are given, *e.g.* at the top of Whalsey Skerries (Zetland), at a height of 74 feet above high water, large blocks up to $13\frac{1}{2}$ tons were found to have been lifted and transported by the waves (p. 45). Again, two blocks of 1350 tons and 2600 tons were shifted bodily at the Wick breakwater in two storms in 1872 and 1877. At Dunbar, pressures of $3\frac{1}{2}$ tons per square foot for the direct wave-action (p. 56), and of 1 ton per square foot for the back-wash (p. 131), were recorded upon a dynamometer of the author's invention; and, by use of two instruments at different levels, it was found that the pressure at the upper level may (exceptionally?) be twice that at the lower level (p. 56). It is much to be wished that extensive and systematic observations of this kind were made, as instances are quoted wherein only 80, 144, and 70 lbs. per square foot had been assumed in the design of lighthouses and harbours (p. 58). Scott Russell's opinion is quoted (p. 106), and accepted, that the most violent action on sea-works is from those waves which form ground-swell or rollers, and are "waves of translation," *i.e.* vast masses of solid water moving horizontally with great velocity; and that the only way of opposing them is by masses too heavy for them to move.

A useful feature of the work is the presentation of 28 cross-sections of quay-, dock-, and harbour-walls, and breakwaters, beginning with the jetty of old Dunkirk (1699); also of 10 cross-sections of lighthouses, beginning with Winstanley's Eddystone (1699).

A chapter (47 pp.) is devoted to materials. A good deal is said about their decay under water. No ordinary material seems free from this. All timber is eventually destroyed by borers (oddly termed *insects* in this work!) of different sorts; even greenheart and creosoted timber, till recently thought borer-proof, have now given way to their special borers. Most stone, and even rock *in situ*, has its own special borer. Iron gives way by rusting, perhaps at a rate of three-quarters of an inch in a century. Bronze alone seems to stand sea-water, but is too expensive to be extensively used.

Ten pages are given to the use of Portland cement concrete, and some remarkable instances of its use are detailed, *e.g.* the concrete cylinder foundations (12 feet diameter, 30 feet length) of the Plantation Quay at Glasgow, and the use of 350-ton blocks (say 5000 cubic feet) laid in 24 feet of water at Dublin (1885).

Attention is drawn to a new and seemingly very promising American cement styled "carbonite," which is said to stand an ultimate pressure of 8000 lbs. per square inch, or *eight times* as much as Portland cement. Trial of this cement in England is much to be wished. Its preparation is apparently a secret, as though four pages are devoted to its use and properties, its main ingredients are only hinted at as being various hydrocarbons.

Two chapters (39 pp.) are given to the difficult subjects of training works for preserving the outfall of harbours and rivers, and preventing silting in estuaries. An interesting instance of the great commercial advantage of even a small increase of depth in a harbour is that of Leith, where an addition of only 2 feet of depth at the Albert Dock gave 296 tides yearly of 23 feet depth against 102 tides of that depth at the Victoria Basin.

Attention is drawn to the disadvantage of harbours being constructed as local instead of as national works. Want of funds has thus repeatedly led to harbours being designed too small for future wants, and being afterwards enlarged at greatly increased cost, the whole works having to be destroyed to make way for the new.

One of the least satisfactory parts of this work is the formulæ, the range of applicability of several of the empirical ones being very doubtful. One (which should have been definite) on strength of lock-gates (p. 191) is misprinted

$$S = \tfrac{1}{2} W \sec \phi + \tfrac{1}{20} \operatorname{cosin} \phi.$$

By reference to the original (*Trans.* Inst.C.E., vol. i. p. 67) it is seen to be

$$S = \tfrac{1}{2} W \sec \phi + \tfrac{1}{20} W \operatorname{cosec} \phi.$$

Moreover, the meaning of W is misquoted as "pressure on the length of the gate, &c.," instead of "pressure on the length l, &c." (l being only the half-breadth of lock), and the meaning of the result S is given, in words which are barely intelligible, as "whole transverse strain at angle ϕ": the context of the original shows that this should be "whole transverse strain applied at middle of gate" (strain being understood to mean pressure). These defects occur in the "Encyclopædia Britannica" (9th ed.) as well as in the separate work (3rd ed.).

On p. 243 a table of values of a "constant" of strength of various timbers is given without explanation of the meaning of the "constant."

Space might have been saved by the exclusion of special subjects, *e.g.* lighthouse apparatus, &c., which could not be treated at adequate length.

A short glossary of uncommon terms would have been decidedly useful, *e.g.* alveus, bollard, kant, pawl, scend, staith.

These blemishes are, however, small compared with the great merit of the work as a whole, which deals with the difficult and important subject of harbours in a thoroughly masterly manner.

ALLAN CUNNINGHAM, (Major, R.E.)

OUR BOOK SHELF

A First Course of Physical Laboratory Practice. By A. M. Worthington, M.A., late Assistant Master at Clifton College. (London: Rivingtons, 1886.)

PROBABLY no one has so successfully carried on practical science teaching in schools as the author whose excellent work at Clifton College has done so much to gain for that institution an enviable reputation. He therefore is specially fitted to write a "First Course of Physical Laboratory Practice" which shall contain just that which the schoolmaster who is endeavouring to supplement mere lectures with the necessary practical work requires.

In the introduction the author explains the system of science teaching at Clifton. He insists on the importance of from the first making boys themselves measure and experimentally confirm geometrical, mechanical, and physical laws, not necessarily with expensive and elaborate apparatus, such as may be best suited for making determinations of the greatest accuracy, but by the most simple and obvious methods, which are likely to lead to results quite accurate enough to show the truth of the law being examined. The pupil is thus from the first taught to learn the value of simple and often extemporised apparatus, instead of acquiring the very general distrust in anything that has not been highly finished by the professional instrument maker.

Here much that is of great value to those intending to introduce practical science teaching into schools will be found, such as descriptions of fittings, original and working cost, and the time that the several courses of instruction should occupy.

The book is divided into nine parts as follows:—1, Mensuration, 23 experiments; 2, Hydrostatics, 15 experiments; 3, Barometer and Boyle's Law, 3 experiments; 4, Mechanics, 39 experiments; 5, Elasticity, 20 experiments; 6, Heat, 42 experiments; 7, Magnetism, 55 experiments; 8, Statical Electricity, 57 experiments; 9, Current Electricity, 16 experiments. The two branches of physics, light and sound, are not included.

The first part is especially valuable as an introduction to laboratory practice of any kind. It is full of examples in which a good way of observation is contrasted with one or more bad ways, so that the pupil soon learns, or ought to learn, method in observation, to choose that way in which error of observation shall least affect the result.

If it is possible to point out any parts as being more excellent than the rest, the chapters on mechanics and elasticity may be mentioned. It is shown how, by means of one or two boxwood scales, a few weights, some pieces of catapult india-rubber (but for sufficient reasons it is not called catapult india-rubber), and some other equally simple and easily obtained articles, a course of experiments of the utmost value can be performed. A pupil must, if he gives his mind to the subject, learn more of the principles of mechanics, of the reasons of things—not the mere "pulley, wedge, and lever" mechanics of the ordinary text-books—than as yet the majority of people have ever acquired.

There is only one sentence which might with advantage be modified as being not strictly correct, though any false impression which it would produce might be removed by the more exact statements five pages later. Having shown that the bending of a lath depends on its length, the author proceeds to show that thickness affects the bending. He says:—"Now take a lath of double the thickness, or, what is the same thing, lay on the first lath a second similar one, and put on the same weight, . . ." This would be a serious blunder to make if the effect of depth were not well shown later. As the fact that the stiffness of a beam is directly proportional to its width is explained by considering it as equivalent to beams side by side, the opportunity is lost, when the effect of depth is considered, of showing that a beam is *not* equivalent to beams lying above one another, and why.

As a text-book for school use, Worthington's "First Course of Physical Laboratory Practice" is highly to be recommended.

Lectures on Heat, Sound, and Light. By Richard Wormell, D.Sc., M.A., Head Master of the City of London Middle-Class Schools. (London: Thomas Murby.)

THE distinguishing feature of this book is its gradually progressive character. The subjects are supposed to be taken in the order in which they are given. "*Heat* being far simpler in itself, and so much easier to explain, is placed first, while *Light*, being essentially more intricate than either *Sound* or *Heat*, is placed last." The lectures on *Heat* are adapted to the minds of pupils when first receiving instruction in a scientific subject; as the mind develops the lectures advance in character, so as to make full use of the increased intelligence of the pupil, and ultimately, when light is reached, the perfection of the undulatory theory can be presented with some hope of its being appreciated.

After each of the three parts questions are given, and, what is far more valuable, a few pages of instruction in laboratory practice.

The book is illustrated by many figures, which are often explanatory diagrams rather than pictures. Such diagrams have far more educational value than cuts from photographs of apparatus, but the want of proportion may be carried so far as to give a misleading idea of what a thing is really like—thus, the gridiron pendulum is shown nearly as wide as it is long.

There is a curious slip in Fig. 30, which shows how waves travelling along paths differing by half a wave-length come together again in opposite phases, and so neutralise one another; while, if there is a difference of one or more complete wave-lengths, the phase is the same, and they reinforce one another. The slip—it can hardly be called more than a slip—consists in showing the *same* number of wave-fronts in the longer as in the shorter path.

That the book should contain much that is excellent is only to be expected of an author of such experience, while the necessity for turning to such trivial details for criticism is sufficient to show that fault of a serious kind cannot be found.

Une Expérience sur l'Ascension de la Sève chez les Plantes. Par Léo Errera, Professeur à l'Université de Bruxelles. *Comptes rendus* de la Société Royale de Botanique de Belgique, tom. xxv. 2ième partie, 1886.

THIS paper contains an interesting contribution to the question of the course taken by the sap of vascular plants on its way from the roots to the leaves. The view taken by Sachs, that the current passes through the substance of the lignified cell-walls, has, as is well known, been disputed by Böhm, Elfving, and many others, who maintain that it ascends through the cavities of the vessels and tracheides. Various observers have endeavoured to bring the question to an experimental decision by stopping up,

in one way or another, the cavities of the water-conducting elements, and then observing whether the current is interrupted. Sachs and Dufour endeavoured to attain this result by sharply bending the stems of actively-transpiring plants, but this method is obviously unsatisfactory, owing to the difficulty of proving that the cavities are completely closed. Elfving attacked the problem in a different way. He injected portions of the stem of woody plants with cocoa-butter, melted at a temperature of 30° C., and satisfied himself that the cavities were really filled up when the injected material had solidified. Under these conditions he found that a pressure of 60 cm. of mercury failed to force any water through the wood, though before the injection 1 cm. of water had sufficed to cause filtration.

To Elfving's experiment two objections have been made. On the one hand, Dufour urged that the absence of the action of transpiration, rather than the closure of the cavities, might well explain the result of the experiment. On the other hand, it was objected by Scheit that the action of the fatty cocoa-butter on the membranes would probably render them impermeable to water, and thus account for a negative result. Prof. Errera has succeeded in modifying Elfving's method in such a way as to meet both these objections.

In the first place, actively transpiring branches were employed for the investigation, *Vitis vulpina* being selected for experiment on account of the large diameter of its vessels. Secondly, instead of cocoa-butter, a solution of gelatine melting at 33° C. was used as the injecting material. This was coloured with Indian ink, so that its presence in the vessels might be easily demonstrated. The action of transpiration was in most cases assisted by the pressure of a column of water 50 cm. in height. The experiments were carried out with all possible precautions, and the result in every case was that the injected branches took up no water, and faded in a few hours, while, under precisely similar conditions, uninjected branches remained perfectly fresh for three days at least, and during that time transpired many cubic centimetres of water. For details and numerical results we must refer to the original.

Prof. Errera's experiments certainly add greatly to the already strong probability that the cavities of the tracheal elements of the wood constitute the channels through which the sap ascends. D. H. S.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

The Lost Found—Boole Justified and Monge Reinstated in His Rights by Prof. Beman of the University of Michigan, U.S.

In the report of my public lecture on Reciprocants, published in NATURE of January 7 (p. 222), mention is made of a formula, given by Boole in his book on "Differential Equations," which he ascribes to Monge.

Endeavours were instituted in London, Cambridge, and Paris to ferret out the passage in Monge in which it occurs, and very diligent search was made, as well in the printed works as in the manuscripts of Monge in the library of the Institute, to accomplish this object.

But all these researches were fruitless, and the opinion was come to by the compatriots of Monge that Boole had made a misquotation, and that the formula ascribed by him to Monge was not to be found in his works. The formula is one of very great interest, as being the first instance on record of a multinomial projective reciprocant.

Knowing how scrupulous and painstaking Boole was, and the least likely of all men to make a quotation at random, I never acquiesced in this belief, but entertained little or no hope that any one would ever succeed in unearthing a reference which had defied all the endeavours of Monge's own countrymen to verify.

But fate had designed otherwise, as will be seen from the subjoined letter. In addition to the satisfaction of a controverted point being settled and Boole's character freed from a rash imputation of inaccuracy, it is to my mind, and will probably be so to many of the readers of NATURE, a peculiar source of pleasure to contemplate the occurrence as an illustration or note of the unity not merely of occupation, but of feeling also, which binds together mathematical workers in all parts of the world.

To think that a task found impossible in London and Paris should have been accomplished in the most satisfactory manner at Yale and Michigan!

Without further comment I submit the letter in its entirety as written, for the insertion which it so well merits in the world-wide-diffused columns of NATURE, and think that all its readers will join with me in according a cordial vote of thanks to Prof. Beman for his valuable contribution to mathematical history.

University of Michigan, Ann Arbor, Michigan, April 3, 1886

PROF. J. J. SYLVESTER, Oxford, England

DEAR SIR,—You will find Monge's form of the differential equation of the conic in his memoir, "Sur les Équations différentielles des Courbes du Second Degré" (Corresp. sur l'École Polytech. Paris, ii., 1809–13, pp. 51–54), and in *Bulletin de la Soc. Philom.*, Paris, 1810, pp. 87, 88; the first as having been contributed directly by Monge, and the second as having been copied from the first.

I have not *seen* the journals myself, but the references have been *verified* for me at the Yale College Library. The actual form is "$9q^2t - 45qrs + 40r^3 = 0$."

The term "Mongian" can now be used without hesitancy by you.

I remember noticing this form when I began reading Boole's "Differential Equations," and I also noticed Halphen's method in Jordan's "Cours d'Analyse." It never occurred to me that Halphen considered the *form* original with himself; I thought that his *method*, probably, of deducing it was different from Monge's.

With kind recollections of having met you at Johns Hopkins once upon a brief visit when Prof. Cayley was there,

I am yours very sincerely,
W. W. BEMAN,
Assoc. Prof. Math.

Since writing the above, in fact this very afternoon, I have received a letter from the Universal Knowledge and Information Office containing the same references as those given by Prof. Beman, which will speak for itself, and cannot fail to draw the attention of the readers of NATURE to the important service which this Society is capable of rendering to all engaged in research of whatever nature in enabling them to discover the origins and hunt up the authorities of any subject on which they may desire to obtain information.

It is certainly a singular coincidence that after the lapse of four months the desired information in this case should have reached me from such widely distant sources at an interval of less than forty-eight hours. The letter, which I inclose, is well deserving of setting out in full. The reference made to the circle at the end is extremely interesting, as it contains an example of a non-homogeneous mixed reciprocant, which in the notation now in use might be written $(1 + t^2)b - 3ta^2$. Or rather, adopting the improved notation, in which $t, a, b, \ldots$ represent

$$\frac{dy}{dx}, \quad \frac{1}{1.2}\frac{d^2y}{dx^2}, \quad \frac{1}{1.2.3}\frac{d^3y}{dx^3}, \ldots$$

it takes the form

$$(1 + t^2)b - 2ta^2.$$

London, April 15, 1886

DEAR SIR,—I am instructed by the management to send you the following in reference to your question relating to the attribution of the differential equation

$$\left(9\left(\frac{dy}{dx^2}\right)^2 - 45\frac{d^2y}{dx^2}\cdot\frac{d^3y}{dx^3}\cdot\frac{d^4y}{dx^4} + 40\left(\frac{d^3y}{dx^3}\right)^3 = 0\right)$$

to Monge by Boole in his "Differential Equations."

In the *Nouveau Bulletin des Sciences, par la Société Philomathique de Paris*, tome ii., Paris, 1810, occurs this passage:—

"Mathématiques.—Sur les Équations différentielles des Courbes du Second Degré, par M. Monge. L'équation générale des courbes du second degré étant

$$Ay^2 + 2Bxy + Cx^2 + 2Dy + Ex + 1 = 0,$$

dans laquelle A, B, C, D, E sont des constantes, M. Monge donne l'équation différentielle débarrassée de toutes ces constantes, et il parvient à l'équation suivante, du cinquième ordre,

$$\text{(A)} \qquad 9q^2t - 45qrs + 40r^3 = 0,$$

les quantités r, s, t, étant définies par les équations suivantes:

$$\frac{dy}{dx} = p, \quad \frac{dp}{dx} = q, \quad \frac{dq}{dx} = r, \quad \frac{dr}{dx} = s, \quad \frac{ds}{dx} = t.$$

"Il faut ensuite voir l'usage de l'équation (A), pour trouver l'intégrale d'une équation d'un ordre inférieur qui satisfait à cette équation (A); ainsi étant donnée l'équation différentielle $(1 + p^2)r = 3pq^2$, il parvient à l'intégrale $(x - a)^2 + (y - b)^2 = c^2$, qui est l'équation d'un cercle.

"La même méthode pourroit s'appliquer aux équations des courbes d'un degré supérieur au second."

A note is added to the effect that "Cet article est extrait de la Correspondance de l'École impériale Polytechnique, rédigée par M. Hachette: 1r cahier du 2e volume, 1810." The press mark of this work at the British Museum is PP. 1543.

Trusting that this is the reference you are in search of, and that the long delay in the discovery of it may be excused when the difficulty of identifying a particular passage (known perhaps only in its full extent to those whose chief work is concerned with such matters) is considered.

I remain, Sir, faithfully yours,
H. FISHER

PROF. J. J. SYLVESTER, &c., &c.

New College, Oxford, April 19 J. J. SYLVESTER

On the Velocity of Light as Determined by Foucault's Revolving Mirror

IT has been shown by Lord Rayleigh and others that the velocity (U) with which a group of waves is propagated in any medium may be calculated by the formula—

$$U = V\left(1 - \frac{d \log V}{d \log \lambda}\right),$$

where V is the wave-velocity, and λ the wave-length. It has also been observed by Lord Rayleigh that the fronts of the waves reflected by the revolving mirror in Foucault's experiment are inclined one to another, and in consequence must rotate with an angular velocity—

$$\frac{dV}{d\lambda}\alpha,$$

where α is the angle between two successive wave-planes of similar phase. When $dV/d\lambda$ is positive (the usual case), the direction of rotation is such that the following wave-plane rotates towards the position of the preceding (see NATURE, vol. xxv. p. 52).

But I am not aware that attention has been called to the important fact, that while the individual wave rotates the wave-normal of the group remains unchanged, or, in other words, that if we fix our attention on a point moving with the group, therefore with the velocity U, the successive wave-planes, as they pass through that point, have all the same orientation. This follows immediately from the two formulæ quoted above. For the interval of time between the arrival of two successive wave-planes of similar phase at the moving point is evidently $\lambda/(V - U)$, which reduces by the first formula to $d\lambda/dV$. In this time the second of the wave-planes, having the angular velocity $\alpha dV/d\lambda$, will rotate through an angle α towards the position of the first wave-plane. But α is the angle between the two planes. The second plane, therefore, in passing the moving point, will have exactly the same orientation which the first had. To get a picture of the phenomenon, we may imagine that we are able to see a few inches of the top of a moving carriage-wheel. The individual spokes rotate, while the group maintains a vertical direction.

This consideration greatly simplifies the theory of Foucault's experiment, and makes it evident, I think, that the results of all such experiments depend upon the value of U, and not upon that of V.

The discussion of the experiment by following a single wave, and taking account of its rotation, is a complicated process, and one in which it is very easy to leave out of account some of the elements of the problem. The principal objection to it, however, is its unreality. If the dispersion is considerable, no wave which leaves the revolving mirror will return to it. The individual disappears, only the group has permanence. Prof. Schuster, in his communication of March 11 (p. 439), has nevertheless obtained by this method, as the quantity determined by "the experiments hitherto performed," $V^2/(2V - U)$, which, as he observes, is nearly equal to U. He would, I think, have obtained U precisely, if for the angle between two successive wave-planes of similar phase, instead of $2w\lambda/V$, he had used the more exact value $2w\lambda/U$.

By the kindness of Prof. Michelson, I am informed with respect to his recent experiments on the velocity of light in bisulphide of carbon that he would be inclined to place the maximum brilliancy of the light between the spectral lines D and E, but nearer to D. If we take the mean between D and E, we have—

$$\frac{K}{U} = 1{\cdot}745, \qquad \frac{K(2V - U)}{V^2} = 1{\cdot}737,$$

K denoting the velocity *in vacuo* (see *Amer. Jour. Sci.*, vol. xxxi. p. 64). The number observed was 1·76, "with an uncertainty of two units in the second place of decimals." This agrees best with the first formula. The same would be true if we used values nearer to the line D.

J. WILLARD GIBBS

New Haven, Connecticut, April 1

The Effect of Change of Temperature on the Velocity of Sound in Iron

I VENTURE to draw attention to an error relating to the above subject, which, originating with Wertheim, still holds a place in some of our modern books on science. According to Wertheim, the velocity of sound in iron and steel is *increased* by rise of temperature not extending beyond 100° C. Now in no sense whatever is this statement correct. It is true that the longitudinal elasticity of iron, as determined by the static method, will be found greater at 100° C. than at 0° C., provided *we begin with the lower temperature first and the wire has not, after the original annealing, been previously raised to* 100° C.; but the apparent *temporary* increase of elasticity is really a *permanent* one (*Phil. Trans.*, part i., 1883, pp. 129–131), and if the wire be repeatedly heated to 100° C. and afterwards cooled, subsequent tests will always show a *less* elasticity at the *higher* temperature than at the lower, if *sufficient rest after cooling be allowed*. When, however, we come to such small molecular displacements as are involved in the passage of sound through a wire, even the apparent increase of elasticity mentioned above vanishes. I have been able to prove that, when an iron or steel wire is thrown into longitudinal vibrations, so as to produce a musical note, the pitch of this note becomes *lower* as we *raise* the temperature, *even when the wire is heated for the first time* after it has left the maker's hands.

It seems rather strange that this error should have so long been allowed to remain uncorrected, for it has been known for many years that the pitch of a tuning-fork made of steel is lowered by small rises of temperature, and the main part of this lowering must be due to the *decrease* of elasticity of the steel.

HERBERT TOMLINSON

King's College, Strand, April 10

Sound-producing Apparatus of the Cicadas

WITH regard to the above subject, treated of in an article by Mr. Lloyd Morgan in February last (NATURE, February 18, p. 368), I may mention that some time ago I examined the drum of the common cicadas found plentifully in the Himalaya near Simla, and which in the evenings send forth a deafening roar from the rhododendron-trees like the whirr of large machinery. Generally the arrangement of the drum and the powerful muscles was as figured by Mr. Morgan, but I also noticed the following particulars not mentioned by him.

The chitinous rods in the membrane of the drum were not parallel, but converged slightly towards one point of the mem-

brane. The effect of this when the sound-producing motion set in was to cause the membrane to wrinkle sharply towards the point of convergence; and, by experiment on the dead insect with the point of a pencil, it was easy to see that the sound was simply produced by this sharp wrinkling of the membrane. If a piece of stiff paper or parchment be held in the fingers, and the thumb be made to play sharply and rapidly upon it in succession, so as to produce a "kink" or wrinkle each time, a very fair representation of the sound of the insect will be produced. A captive insect, when the motion is slowing down, can be advantageously watched; it will then be seen that, as the sound divides up into separate clicks, the membrane becomes alternately wrinkled and flat. Beyond doubt the sound is no humming. C. S. MIDDLEMISS

North-West Himalaya, March 14

Ferocity of Animals

I HAVE read with interest the article by Prof. Lloyd Morgan "On the Study of Animal Intelligence" in the present number of *Mind*, in which he touches upon the subject of entangling fact and inference which attracted my attention when reading "Mental Evolution in Animals" some time since.

I write to call Prof. Morgan's attention to the excellent example of "ejective inference" given by Dr. Romanes in his letter in NATURE for April 1 (p. 513), where he says of a rat that he "perfectly understood my object." Would it be troubling Dr. Romanes too much to ask him to explain the appearance a *wild* rat presents on "perfectly well understanding" the object of a human being's actions?

Churchfield, Edgbaston, April 5 F. H. COLLINS

Tropical Dew

HAVING had occasion to lay out a large quantity of iron hoes and picks, without handles, on the hard ground of an open inclosure in one of the driest districts in India (Bellary), where, in fact, these implements had been collected in the face of a scarcity, it was found, after they had lain a couple of months, that a thick, weedy, but luxuriant vegetation had sprung up, enough, though there had been no rain, to almost hide the tools.

The effect depositing tools on grass has had in stimulating its growing the writer has observed in the tropics before, but was at a loss to account for it, except upon some irresolvable theory of radiation or magnetism.

The whole phenomenon is cleared up by Mr. Aitken's paper on "Dew" in NATURE of January 14 (p. 256), dew being proved deposited, not, as generally thought, from the air above, but rising and condensing from the soil below; and the ground in India is always hygroscopic. The outer surfaces of the iron tools radiate of course quickly at night, and the stratum of air inclosed between the metal under surfaces and the earth is therefore saturated with condensing moisture.

That iron gratings laid on bare ground will raise a rank vegetation in places with only 10 or 15 inches of annual rainfall, and exposed to tropical heat, is a not unimportant fact, as being a readily available substitute for irrigation water, worth further investigation. A. T. FRASER

India, March 26

The Climbing Powers of the Hedgehog

I AM advised by some of my friends to send you a notice of the mode in which hedgehogs may frequently escape from confinement, and of their habits.

I obtained a hedgehog last week, and put it in my kitchen. Every day it is placed in a small back area, about 12 feet square, during the day-time. The waste-pipes from the cisterns discharge into this area, and the animal frequently lies under these, and, as my servant says, "wallows in the trough like a pig." If he hears any noise he at once runs to a corner and rolls himself up.

On Wednesday the servant found him on the top of the partition wall between my area and the next. This wall is vertical, height 9 feet 6 inches. The top course but one projects 1 inch, so he must have climbed over this.

He has been watched in the operation. He climbs by the projecting mortar beds, which are rather rough, looking about him frequently to see if he is watched. He climbs up the house wall beside the pipe in the corner—an ordinary iron rain-pipe; but from the shoulder of the pipe, where it passes through the wall, to the top of the partition wall, there is a distance of 9 inches without any pipe, so up this portion and over the projecting brick course he must have climbed by clinging to the wall of the house or the partition wall.

Yesterday (Thursday) he repeated the ascent, and descended into the next area, where he was found this morning.

ROBERT H. SCOTT

6, Elm Park Gardens, April 16

STARS WITH BANDED SPECTRA[1]

THE spectroscopic survey of the northern heavens, undertaken conjointly by MM. Vogel and Dunér in 1879, has already progressed so far that its general results can be fairly anticipated—its immediate results, that is to say; for it is ultimately designed, not so much for a collection of statistics, however valuable and interesting, as for a criterion of change. This effect, however, must wait for the future—perhaps a remote future—to develop; we can in the meantime gather much present knowledge through labours inspired by still unfolded possibilities.

The first instalment of the first spectroscopic star-catalogue systematically executed, was published by Vogel in 1883 (*Publicationen* des astrophysikalischen Observatoriums zu Potsdam, No. 11). It covers a zone of the heavens extending from $-2°$ to $+20°$ of declination, and includes 4051 stars down to 7·5 magnitude. M. Dunér now sends us from Lund, in a catalogue of 352 stars fully ascertained to possess spectra of the fluted and zoned types, a work of special and extreme importance.

Stars with banded spectra fall into two perfectly distinct classes, of which the first is well exemplified in α Orionis (Betelgeux), the second in a 5·5 magnitude star close behind the Great Bear, numbered 152 in Schjellerup's Catalogue of Red Stars (*Astr. Nach.*, No. 1591), and called by Father Secchi "La Superba," from the extraordinary vivacity of its prismatic rays. The spectrum of Betelgeux (Fig. 1) shows a series of seven or eight well-marked dark bands (besides minor shadings) all abruptly terminated towards the violet, and dying out by insensible gradations towards the red. The impression upon the eye resembles that of a colonnade thrown into strong relief by a vivid side-illumination. Only three conspicuous dark spaces, on the other hand, interrupt the beams of 152 Schjellerup (Fig. 3); but their breadth is fully twice that of the flutings in the spectrum of α Orionis; and, still more remarkable, they *face in the opposite direction.* Their obscurity deepens slowly downwards towards their less refrangible sides, then suddenly, by a sharp transition, and with a singular and splendid effect of contrast, gives place to unclouded light.

The stars characterised by these two different qualities of absorption, respectively constituted Father Secchi's third and fourth spectral orders. M. Vogel, however, saw fit in 1874 (*Astr. Nach.*, No. 2000) to modify the arrangement by grouping the two varieties together as subdivisions of a single class. Nor was this a mere arbitrary change. It was the outcome of a far-reaching speculation regarding the course of development taken by the great army of suns marshalled in the profundities of space.

Secchi's classification involved no hypothesis of any kind; it was founded simply on appearances. But the idea that the colours, consequently the spectra of stars, may guide us to a knowledge of their comparative "ages," thrown out in a crude shape by Zöllner in 1865, had, meantime, made its way. Vogel's adoption of it as a means of rationalising observed particulars, gave it (perhaps prematurely) a recognised scientific status.

According to this view, the white stars forming Secchi's first order (of which Sirius and Vega may be taken as

[1] "Sur les Etoiles à Spectres de la Troisième Classe." Par N. C. Dunér. Mémoire présenté à l'Académie Royale des Sciences de Suède, le 11 Juin, 1884. (Stockholm, 1884.)

representative), are in the initial stage of their life as suns. Their energy is still unwasted; their temperature is enormously high; their light is not sensibly modified by absorption, hydrogen being the only constituent of their atmospheres capable of strongly intercepting their radiations. But with the lapse of ages, this early fervour cools down, and absorption gains strength. Hydrogen no longer stamps itself predominantly upon their spectra; metallic rays deepen and multiply; a dusky veil is drawn across each photosphere, stopping preferentially its more refrangible emissions, and thus imparting a yellowish tinge to the resulting light. The condition of our sun, as well as of Capella, Pollux, and Dubhe, is, in short, reached. Down to this point the history of all ordinary stars is the same. Here, however, a bifurcation in the path of development is reached. Two roads to extinction are now open to them. For, according to Vogel, the two varieties of banded spectra mark co-ordinate, not successive, stages in stellar existence. The choice, so to speak, once made, is definitive. Migration from one type to the other is impossible. Hence Vogel's abolition of Secchi's fourth type, and his distribution of such stars as Betelgeux and α Herculis on the one hand, and 152 Schjellerup and 19 Piscium on the other, into two alternative branches of his third. But let us look a little more closely at facts before admitting conjecture.

M. Dunér's Catalogue includes 297 entries under the heading Class III. *a* (type of α Orionis), to which in all 475 stars are so far known to belong. A particular description of each spectrum, from his own and others' observations, is appended; so that ample materials are provided for some few safe generalisations.

The first point to be noted is that the positions of the leading bands in *all* spectra of this kind are absolutely unchanging. The series is repeated with varying degrees of intensity from star to star, almost as if in stereotype. The shadings are, it would seem, in reality made up of fine lines very closely grouped. D'Arrest and Huggins, at least, repeatedly succeeded in thus resolving them, although to Vogel, even when employing most powerful optical means, they persistently maintained a nebulous appearance. Now a glance at the accompanying figures will show a symmetry in the arrangement of these bands suggesting that they result from the rhythmical vibrations of one highly complex molecular system. In other words, they betray the absorptive action of a single substance; particular identification is awaited; nor is it easily attainable. Great difficulty attends inquiries into the direct spectra of compound bodies, since the very means employed to render them luminous, also tend to destroy, by forcing them asunder into their constituent elements.

Besides this unknown substance, however, metallic vapours exist abundantly in the atmospheres of Betelgeux and its congeners. The grooved spectrum distinguishing them might in fact be regarded as superposed upon a modified Fraunhofer spectrum. Not only in its bright spaces, but even across its dusky flutings, a crowd of significant dark rays can be perceived. Their number, as disclosed by the 27-inch Vienna refractor in September, 1884, in the spectra of β Pegasi and α Herculis, took Vogel altogether by surprise (*Publicationen*, Potsdam, No. 14, p. 22). Yet he and Dr. Huggins had already measured no less than 95 such in the analysed light of Betelgeux. Some of these can be identified with terrestrial substances. Sodium, iron, magnesium, calcium, and bismuth, are without doubt incandescent above the photosphere of that star. Lines of hydrogen have also been made out, and its presence is certified by Dr. Huggins's photographs. Its absorption is, however, inconspicuous in all, and imperceptible in most spectra of this description.

One of their most singular features, as yet unexplained, is that dark metallic rays form the sharp boundary of many of the flutings. Thus calcium-lines (wave-lengths 616·4 and 585·6) respectively terminate, on their more refrangible sides, the bands numbered 2 and 3 in the figure; strong contiguous lines of calcium and iron limit band 4; band 5 ends with the well-marked iron lines of wave-lengths 545·0 and 544·4, and band 8 with that of 495·8; band 7 with the solar group *b*; band 9 with a deep furrow of unknown origin. These coincidences are extremely puzzling; for, as M. Dunér remarks, they can scarcely be accidental.

Stars with fluted spectra are all more or less deeply tinted with orange, owing to the stoppage, by a general absorption, of by far the greater part of their blue rays. Their actual emissions must then be very greatly in excess of those reaching outer space. Stripped of its surrounding atmosphere, our sun, it is computed, would leap up to some three or four times its present lustre; but in stars like Betelgeux, absorption must at least quadruple its solar effects. This consideration is of fundamental importance in any estimate of the relative luminous power of the stars.

Fifty-five members of Class III. *b* find a place in the Lund Catalogue. These are all that have hitherto been discovered. Yet exploration, in their case, is more complete than with the previous type, the broad, deep zones of their spectra being distinguishable in objects much too faint to show the narrower groovings of Class III. *a*. No star of this kind is as bright as the fifth magnitude, while eight between ninth and tenth are included in M. Dunér's list. Thus, although the fluted spectra already examined outnumber those in zones (as we may call them for the sake of distinction) scarcely nine times, M. Dunér considers that the real proportion of their excess is at least fifty to one.

The rare objects constituting Class III. *b* are amongst the most interesting in the heavens. For they exhibit in their spectra the unmistakable signature of that substance which, more than any other, deserves to be called the material basis of life. Father Secchi (their original discoverer) regarded them from the first as "carbon-stars;" but Dr. Huggins in 1872 tested the supposition (for it was then little more), and rejected it as disproved. There is now no doubt that the Roman observer was in the right. The three conspicuous bands of dense absorption visible in such spectra agree in position quite closely with the emissions of carbon-vapour glowing in the electric arc. Dr. Huggins gives scanty details of his observation (see Schellen's "Spectrum Analysis," ed. 1872, p. 504); he is rarely in error; but on this occasion was perhaps misled by the facile emergence of acetylene-bands, of which the blue one falls just in the intermediate position indicated by him as fatal to the suggested identity.

Besides carbon, sodium is without doubt present in the atmospheres of these remarkable bodies; and there are signs of further metallic absorption, notably by iron. Their rays being, however, too faint to bear scrutiny with a narrow slit, the finer features of their spectra remain, for the present, unrecognisable. Yet we cannot avoid being struck with the circumstance that their most prominent constituent elements are precisely those which kindled in the great comet of 1882 as it approached the sun.

The "zoned," like the "fluted" stellar spectrum, is, in general outline, invariable, though capable of endless individual modifications of tone and detail. It is as if one fundamental sketch-plan were filled in with the most diverse depths of shading.[1] Another point on which all such stars agree, is the redness of their light. The violet end of their spectra is, uniformly, all but obliterated; not necessarily through original deficiency. The more refrangible emissions of 152 Schjellerup may, for aught we

[1] See Figs. 4, 5, and 6; the last a supposed example of a "transition" spectrum given by a star in course of passing from Class II. *a* (solar type) to Class III. *b*.

can tell, be as copious as those of Sirius or Vega. But they are intercepted in a deeply-laden atmosphere, which can indeed be escaped by only a small per-centage of their entire radiations. This explains at once the uniform inconspicuousness of such objects. A star of this class should possess, say, a hundred times the radiating surface of Vega, to send us, from an equal distance, the same quantity of light.

No star of those yet known to show banded spectra of either kind has an ascertained parallax. This is not wonderful, since the stars at measured, or perhaps measurable, distances from the earth, constitute a scarcely perceptible fraction of the whole. Still, the fact remains that all members of the two classes under consideration are indefinitely remote. We are accordingly without the means of estimating, even in the most general way, the real quantities of matter contained in, or of light emitted by, them. We can only say that their dimensions must be very great in proportion to their apparent magnitudes.

The question of their distribution is of much interest, as involving their relations to the vast ground-plan of the sidereal system. And one circumstance connected with it becomes immediately evident. This is, their largely predominant occurrence in and near the plane of the Milky Way. M. Dunér, it is true, considers that they merely obey the general law of stellar condensation. But this law applies more and more closely to the lessening orders of stars; and we have just seen that, physically, stars characterised by strong absorption should rank with stars optically by many degrees their superiors. The hypothesis, then, of some special connexion with the galactic streams and rugosities is by no means excluded; and it is countenanced by statistics as to the distribution of red stars in the southern hemisphere, recently afforded by M. Pechüle ("Expédition danoise pour l'Observation du Passage de Vénus," 1882, p. 38).

One of the most assured peculiarities of stars with banded spectra is their marked tendency to fluctuations of light. Amongst innumerable examples of this connexion may be cited "Mira" Ceti, and Gore's "new star" in Orion, both of which display brilliant prismatic flutings. Nearly all variables, in fact, save the few which complete their cycle of change in a few days, belong to one or other of the subdivisions of Class III. Whatever may be the secret of their constitution, it is indissolubly bound up with the still mysterious cause of stellar variability. We can scarcely penetrate the one without divining the other. Already something is gained by the mere fact of the connexion being established. We learn from it that the steadfast shining of a sun or star is conditioned by the quality of its surrounding gaseous envelope. Continuous study, then, of the spectra of variables affords probably the best chance of progress in knowledge of their nature. M. Dunér's incidental observations show that the reinforcement and extension of banded absorption apparent at minima, do not sufficiently explain the diminution of light, which must accordingly be in part due, either to a real failure of emissive power, or to an increase of general absorption. The analogy of sun-spots favours the latter alternative.

M. Dunér concludes his valuable memoir with the admission that the order of stellar development postulated by Vogel, and advocated by himself, may, after all, be the inverse of that pursued in nature,—a possibility surely worth thinking about.

The heavens are no longer in our eyes "incorruptible." Reason and revelation alike lead us to seek for symptoms of growth and decrepitude in their bright inmates. Not in human affairs alone "the old order changeth, yielding place to new." But the subject is one on which we are without the guidance of experience, and can scarcely hope to acquire any, regard being had to the almost infinite disproportion between our hurried notions of time, and the unimaginable leisureliness of cosmical progression. Caution is then all the more needful, if we would avoid wide wandering from the truth.

Now it has to be objected to Vogel's scheme, that it gives no account whatever of suns in process of becoming. Yet they must be as numerous, one would think, as suns in process of decay. From the summit of brilliancy and vigour, the course of decline is traced downward towards the final quenching. But what of the other branch of the curve? Stars now at their acme of splendour must have passed through long periods of preparation. Sirius and Canopus, we are fully assured, did not all at once blaze out in their present radiance. What, then, we cannot abstain from asking, was their anterior condition? What quality of light did they emit? How were their atmospheres constituted? What kind of spectra, in short, would they then have afforded? A system of classification, based on the supposed order of stellar development, in which no account is taken of this wide branch of the inquiry, must be regarded as essentially incomplete.

A. M. CLERKE

THE INSTITUTION OF NAVAL ARCHITECTS

THE twenty-seventh annual session of the Institution of Naval Architects, held at the rooms of the Society of Arts, was one of the most successful of the series. The meetings began on the 14th inst. and concluded on the 17th. There were seven sittings, averaging from three to four hours each, and no less than eighteen papers were read and discussed. As on previous occasions, too much was attempted to be done in the time available, with the result that some important matters received scant notice. This may be to some extent inevitable in a Society embracing such wide and varied interests, yet meeting but once a year. But it may be anticipated that the autumn meetings in the outports which are now contemplated may somewhat relieve the congestion in future.

Lord Ravensworth presided as usual, and delivered a Presidential Address, in which various matters of interest were touched upon, *inter alia* the use of liquid fuel instead of coal in steamships, the development of triple-expansion engines, the prospects of shipping and the statistics of shipbuilding, including the extended use of steel. It may be hoped, although the immediate future scarcely justifies the expectation, that before the next meetings a change in circumstances may enable the President to speak more cheeringly. On the other hand, it is an undoubted fact that the period of depression through which the country is now passing is forcing into prominence inquiries into possible economies in the construction and propulsion of ships which might otherwise have been neglected.

No less than seven of the papers read had relation to the propulsion of steamships. The first on the list—"On the Speed Trials of Recent War-Ships"—was read by Mr. W. H. White, Director of Naval Construction. It contained a succinct account of the remarkable advances made during the last quarter of a century in the speeds and propelling machinery of war-ships. The fact that huge battle-ships carrying enormous weights of armour and guns are now driven at speeds of 17 to 18 knots—20 to 21 miles per hour—is sufficiently remarkable. Yet the fact that such a ship, weighing 10,000 tons, can be driven 9 knots in an hour with an expenditure of only 1 ton of coal is no less striking. Much has been learnt, too, of late years as regards the influence of *form* upon the resistances of ships; thanks, in great measure, to the researches of the late Mr. Froude, whose work received the substantial support of the Admiralty. In the paper above mentioned it was shown that by suitable selection of form, the *Howe*, a vessel of 9600 tons, 325 feet long and 68 feet broad, was driven as easily as the *Warrior*

up to the highest speed reached by the latter, although she was 380 feet long, 58 feet broad, and of 8850 tons only. The *Warrior* reached 14½ knots only; the *Howe* attained 17 knots. Improvements in marine engineering made this tremendous speed possible in the *Howe*. In her each ton weight of propelling apparatus corresponded to 10 indicated horse-power; in the *Warrior* 6 indicated horse-power required 1 ton. This economy of weight in the propelling apparatus was shown to be due to several causes, including a higher steam-pressure, quicker-running engines, the use of forced draught in the stoke-holds, and the introduction of wrought iron, steel, and gun-metal instead of cast iron.

Two papers dealt with the interesting subject of "forced draught" from different points of view. Mr. Sennett described at some length the Admiralty system of "closed stoke-holds," by means of which air is delivered into the boiler-rooms by powerful fans, and at a sensible pressure. The stoke-holds being thus *in plenum*, the air can escape only through the furnaces, and combustion is quickened greatly. With the best *natural* draught, about 10 indicated horse-power per square foot of furnace (or grate area) is considered a good performance: with forced draught and closed stoke-holds, this may be increased from 60 to 80 per cent. It will be seen therefore that for war-ships, which only require to steam occasionally and for comparatively short periods at full speed, the system is admirably well adapted. And it has been proved to be not nearly as wasteful of fuel as might have been supposed; while it certainly makes the stoke-holds cooler and more comfortable to work in. For the mercantile marine the conditions are different: ships have to steam ordinarily at practically their full speed; the restrictions of weight and space are not so great as in war-ships; and economy in coal consumption is of primary importance. Still even here forced draught promises to supplant natural draught, and to enable large economies to be made in weight and size of boilers concurrently with savings in coal. Mr. Howden described his system of forced combustion, which has been tried at sea over a long period, and promises to be successful. He does not close in the stoke-holds, but delivers air under pressure from fans direct into the furnaces and ash-pits, this air having been heated by passing through a special apparatus placed in the up-takes. Great economy is claimed for this system, and it was well spoken of by competent authorities in the discussion which followed. Competing plans are also being tried, so that more will certainly be heard of forced draught in the mercantile marine. Hitherto economy has been sought in higher pressures and in the *use* of steam in the engines: now engineers are turning attention to the boiler, and the means of generating steam with a minimum expense.

Hard times in the mercantile marine have led to a wholesale conversion of compound engines into engines of the triple or quadruple expansion type. Mr. Cole read a thoughtful and well-considered paper on this subject, which is of general interest to shipowners just now. It may prove a very desirable thing to reduce the coal-bill by 20 per cent., even at the cost of converting the machinery to the more highly expansive type.

It is a natural transition from the propelling machinery to the propellers of steamships. Mr. R. E. Froude, who has succeeded his father in the superintendence of the Admiralty model-experimental works, contributed one of the most valuable and scientific papers read at the meetings, on "The Determination of the most Suitable Dimensions for Screw Propellers." He attempts from experiments with models of ships and screws to ascertain the resistance experienced by a ship moving at a given speed, and the "augment" of that resistance produced by the action of the propeller behind her. By means of a lengthy series of experiments with model screws he further attempts to fix the best diameter and pitch for a given number of revolutions of the engines. And finally, the results are thrown into a form adapted for practical use. The paper is in all respects admirable, but we are bound to say that it can be regarded only as another step forward on a very difficult road, and may be treated as provisional rather than conclusive. Some of the inferences do not accord, either, with the results of general experience. It is to be welcomed, however, for as yet the theory of the screw propeller is not in a satisfactory condition; and it is well known that very remarkable economies are frequently realised by changes in propellers. In the course of the discussion Mr. White mentioned a case of recent occurrence, where, by a change of screw only, the speed of a ship was raised from 12 to 13¼ knots per hour.

M. Marchal, of the French Génie Maritime, contributed an interesting paper, in which the results of a number of experiments, made by order of the Government, were described. It was desired to obtain data for guidance in deciding on the relative advantages of two or three screws as applied to an ironclad of 10,000 tons. A model steamer of 10 tons was built, and tried at "corresponding speeds," with two screws and with three. The publication of this paper marks a distinct change of policy in France, and it places before English designers a mass of valuable facts, which may prove very useful hereafter as the speeds of ships are increased.

Mr. Hall read a paper on "Flexible Shafting for Screw Steamers," describing a plan by which he hopes to reduce the number of breakages or serious accidents to the screw shafts of ocean-going steamers. His contention was that in not a few cases there is a want either of accuracy in the line of shafting and shaft-bearings, or of rigidity in the hulls of steamships; so that, by special joints between the various lengths of shafting, a certain amount of flexibility might advantageously be secured. Experience will prove whether he is correct or not in the anticipation that his plan will reduce accidents or breakages—serious matters in single-screw ships carrying large numbers of passengers and having very small sail-power.

Another important group of papers are those dealing with the use of rolled and cast steel for shipbuilding. It is well known that steel is rapidly gaining upon iron, and Mr. Martell (of Lloyd's) stated some very interesting facts as to the extension of its employment in the mercantile marine. War-ships are now all steel-built. Seven years ago only 4470 tons of steel ships were built as against 518,000 tons of iron ships. In 1885 over 165,000 tons of steel ships were built as against 290,000 tons of iron. Confidence in steel was expressed by Mr. Martell in his paper, echoed by Mr. Ward in another excellent paper recording eight years' experience in building steel ships, and indorsed by all who took part in the discussion. Incidentally the question arose of the introduction of steel made by the "basic" process for shipbuilding purposes; as yet this "make" of steel has not found much favour, but the Admiralty authorities are now about to undertake a series of experiments from which much may be learnt. Every one agrees that thorough and systematic testing has done much to secure the excellent qualities of steel now made by both the Bessemer and the Siemens processes; and even the manufacturers are in favour of maintaining the full severity of the tests in order to prevent any deterioration in quality. Of more recent date than the use of "mild-steel" plates and bars is the introduction of mild-steel castings in lieu of iron forgings. Mr. Warren, who had been chairman of a Committee appointed by the Admiralty to look into this question, gave to the meeting an excellent summary of the results of their inquiries. There can be no question but that heavy iron forgings are doomed to give place to steel castings, which can be produced rapidly and cheaply, of sound and ductile quality, and in finished forms, avoiding

costly machine-work. As a record of experience up to date, Mr. Warren's paper will have a permanent value.

The remaining papers on the list are of a miscellaneous character, but all of considerable interest. Mr. Heck described a "Mechanical Method of Finding the Stability of a Vessel," by means of a simple model. This is a very ingenious and labour-saving device, likely to prove of great assistance in ordinary ship-yards, where a staff of trained calculators may be wanting. Mr. Stromeyer described a "Strain Indicator" which he has invented. This instrument is extremely simple in its construction: the essential parts consisting of two flat plates between which is inserted a "rolling-pin" of fine steel wire. Relative motion of the two plates causes the rolling-pin to rotate, and its rotation is the means of measuring the strain to which the material is subjected in any portion of a sample or a structure to which the indicator may be attached. If this instrument answers as well as it promises to do, much will be learnt from its indications as to the strains brought upon ships under various conditions and more especially at sea. Such information carefully compiled and collated ought to prove of value in determining the structural arrangements of ships.

Admiral Paris, the venerable Curator of the Naval Museum at the Louvre, long known for his eminence as a scientific naval officer and as an archæologist in shipbuilding, attended the meetings, and contributed an interesting paper on the "Rolling of Ships," exhibiting an instrument designed to represent the relative movements of ships and waves. His reception was deservedly cordial.

Capt. Colomb described, in a well-written paper, some of the more important results of recent measurements of turning powers of ships in the Royal Navy. These trials are now systematised, and much has been learnt from them which will be of value to future naval tactics, as well as useful to shipbuilders in designing rudders and steering-appliances. A novel steering-gear was described by Mr. Maginnis, who also laid before the Institution some valuable autographic information on the obscure subject of the strains brought upon a rudder when it is "put over" to various angles in a ship moving at speed.

Mr. Read's contribution, "On the Strength of Bulkheads" in ships, was seasonable, the recent loss of the *Oregon* having again drawn public attention to the necessity for water-tight subdivisions as a means of safety from foundering. Mr. Read put into a mathematical form the principles which should regulate the construction of bulkheads if they are to successfully withstand the water-pressure which must come upon them when the compartments are "bilged" and sea-water enters. He did not deal with the principles which should govern the disposition of bulkheads; but these principles are well understood, and more generally acted upon now than formerly.

Another paper by Mr. Benjamin described a "Proposed Steam Lifeboat" which had been designed to be practically uncapsizable; and for that purpose, among others, made of a very peculiar form. The only other paper on the list described the improved methods of working anchors and cables devised by the author, Mr. Baxter. This was a paper of a practical and historical character, on a subject of undoubted importance.

From this hasty summary it will be seen that the Institution of Naval Architects maintained at its recent gatherings its old reputation for widely diversified topics of discussion. And it is to be added that the papers as a whole, numerous as they were, were also of more than average merit.

ON THE USE OF MODELS FOR INSTRUCTION IN THE MAGNETISM OF IRON SHIPS

THE deviations of the compass produced by the iron used in the construction of wooden ships was a source of considerable perplexity to the navigators of the last and early part of the present centuries; and no sooner were these difficulties fairly overcome than the building of ships entirely of iron commenced.

With the introduction of iron ships, prolonged investigations into their magnetism and the resulting deviations of the compass on board were undertaken by some of the most eminent philosophers and mathematicians of the day, the subject being still one which occupies the attention of many observers, from the increased use of iron in the equipment, as well as construction, of the hulls and decks. These investigations were much facilitated by the increased knowledge of the earth's magnetism, which received such notable additions from magnetic surveys made by travellers on land and navigators at sea during the years 1819-45.

Moreover, as time rolled on, these observations were embodied in trustworthy graphic representations of the declination or variation, the dip or inclination, and the horizontal force, which have done such good service in the work of obtaining a clear understanding of the cause of the magnetism of iron ships, and the changes to which such magnetism is liable when the vessel's position is altered either geographically or in respect to the magnetic meridian.

It is not here intended to enter into any historical *résumé* of the names of the several investigators in this branch of science, nor of the results which each obtained, but to indicate at once where the physicist and mathematician may find the theory and examples of its application; also, how the practical results of this elegant theory may, by the use of models, be made intelligible and available to the seaman and other inquirers who have neither the time nor the opportunity for abstruse studies requiring considerable mathematical knowledge.

The text-book which is now generally accepted in all countries is the "Admiralty Manual for the Deviations of the Compass," in Appendix No. 1 of which will be found the three fundamental equations of Poisson, which form the whole theory of the deviations of the compass, and the expressions of these equations "in terms of the quantities which are usually given and required," written by the late Archibald Smith, M.A., F.R.S.

The whole of the action of the soft iron of a ship is represented in these equations by the parameters a, b, c, d, e, f, g, h, k, and in a model by nine soft iron rods fixed in definite positions, distinguished by the same letters.

The effects of the magnetism of the hard iron of the ship are represented in these equations by the parameters P, Q, R, and in the model by two permanent magnets held horizontally in definite positions, and a third permanent magnet held vertically under the compass.

One of the most important contributions to magnetical science as regards iron ships was made by Sir George Airy (late Astronomer-Royal) in a paper published in the *Phil. Trans.* Royal Society for 1839. After making a series of experiments in certain iron-built ships, he discussed the results mathematically with the purpose of discovering a correction for the deviation of the compass. He concluded his paper with the announcement of his invention of the system of correction by magnets and soft iron, which is universally practised in the present day, always with advantage, and often as a matter of necessity in ships of certain types, where to find a suitable place even for the standard compass is a matter of no small difficulty. This system of correction, coupled with the analysis described in the "Admiralty Compass Manual," provides the means of correcting a compass even in position on the 'tween decks of our armour-plated ships of war.

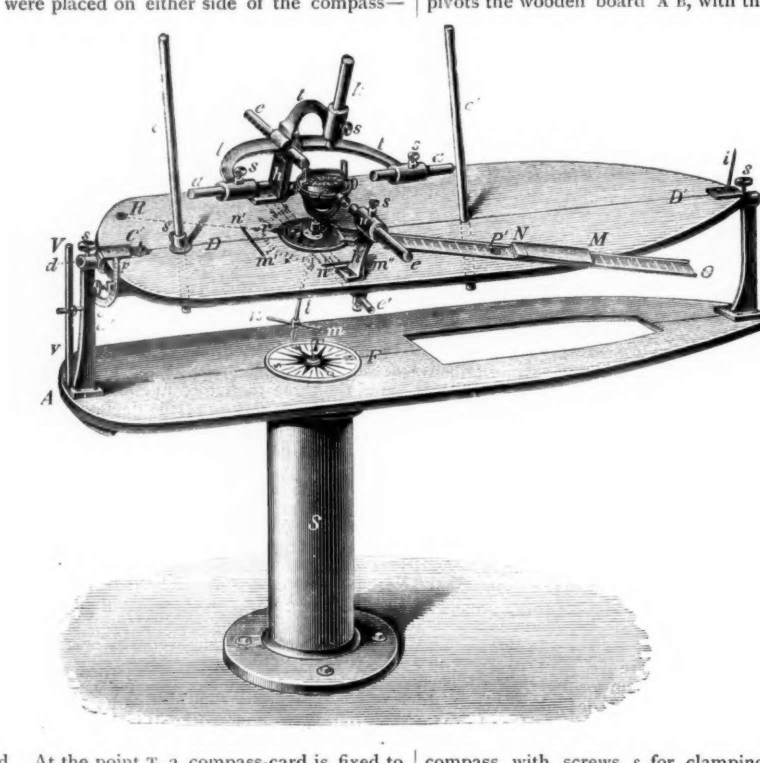
With these preliminary remarks, the description of some different forms of models will be given, and their uses for instruction in the magnetism of iron ships considered.

One of the first of these instructive models was that constructed for Sir George Airy, and used during his lectures to illustrate his method of correction of the deviations of the compass. It consisted of a model of the wooden hull of a vessel. In the centre of the deck a compass was mounted, disturbing magnets and pieces of soft iron being concealed underneath it, producing semicircular and quadrantal deviations as in an iron ship. These deviations were then corrected by placing the model ship with its bow alternately on the north and south magnetic points, when the compass was made to indicate the same directions by means of transverse magnets on the deck; and then on the east and west points magnetic, the correction of the semicircular deviation being completed by longitudinal magnets on the deck. Lastly, with the model placed in a north-east and south-west direction magnetic, scrolls of soft iron were placed on either side of the compass—an imaginary line transverse to the model passing horizontally through the centre of the scrolls and compass-card—until the compass pointed correctly.

Of more recent models there are three which are of an instructive character: one designed by Dr. Neumayer of the German Naval Observatory at Hamburg; the second in England by an official of the Board of Trade; and the third, which is the most complete both for experiments and purposes of instruction, by the United States Navy Department.

The accompanying woodcut on the scale of one-twentieth of the original model is taken from Paper No. 2 of the *Archiv der Deutschen Seewarte*, VI. Jahrgang, 1883, where an account of the experiments to be made with it is given in full detail. The following is a description of the several parts shown.

S is a pillar fixed in the floor of the room, upon which pivots the wooden board A B, with the line of its central



axis marked. At the point T, a compass-card is fixed to S, with its north and south points adjustable in the magnetic meridian.

Supported by the two brass uprights $a' b'$, is the second board in the form of a ship's deck pivoting at $d\,d'$, so that it can be inclined sideways, as when a ship inclines under pressure of sail or when rolling, but kept horizontal as required by the screws $s\,s$. An arc, $o\,p$, marked to degrees, shows the angle of inclination. A gimballed compass, C, with sight vanes, is mounted on the deck, and when the lubber's point and the pin i are in line, as seen through the vanes, the compass support is secured by the clamping-screw. O P′ is a graduated arm revolving round the base of the compass stand, grooved to receive a bar-magnet, and with a pointer, r, showing the number of degrees the arm has been turned in azimuth. h and h' are brass bearers for carrying the rods of soft iron used in disturbing or correcting the compass, with screws, s, for clamping the rods at any required distance.

The model, as described thus far, is entirely free from any magnetic body external to the compass, and may, by means of the latter, be placed with its marked axis in the magnetic meridian, the compass card at T being fixed in that direction for future reference. The means for producing the disturbing forces on the compass similar to those found in iron ships are these. M N is a magnet, which may be so adjusted in the groove that, by moving the arm O P′ in azimuth, semicircular deviation of any desired form may be produced. In the figure the magnet M N is placed to produce the semicircular deviation of a ship built with her head north-north-west, and the resulting south (or blue) pole is found in the point R. The soft iron rod V v in its vertical position represents the stern-post of a ship, producing that part of the semicircular deviation in compasses placed near it, which

changes as the ship moves into fresh magnetic latitudes. $c c'$ are soft iron rods, intended to represent iron masts.

Quadrantal deviation of the form generally observed is produced by the soft iron rod e', extending from side to side under the deck D D′ like a deck beam, the rods $a a$ also conspiring with e' in increasing the quadrantal deviation. That part of the heeling error caused by the magnetism of the hard iron of a ship is produced by a small vertical magnet in the position of the rod l when removed; that from soft iron by the vertical soft iron rod k and the horizontal rod e'.

The compass C having been disturbed by magnetic forces of the usual type in an iron ship, may now be corrected: $m'' n''$ is a magnet with its north or marked end, n'', towards the stern of the model, and near enough to the compass to correct the deviation on the east and west points: $m' n'$ is a second magnet with its north or marked end, n', towards the port side, correcting the deviation on the north and south points. Or the whole semicircular deviation may be corrected by one magnet, $m n$, placed exactly in the direction of R, n being the marked or north end. The quadrantal deviation is corrected by the rods $e e$. The heeling error caused by e' is also nearly corrected by $e e$, and that caused by the sum of the effects of k and the vertical magnet under the compass by another vertical magnet with the opposite pole uppermost.

Thus it will be seen that any component part of the whole deviation usually found at the standard compass of an iron ship may be produced in the model and the corresponding corrector provided.

The portable model adopted by the Board of Trade has a compass mounted on a ship's deck, as in the figure; but the deck, which rests on a central metal support, revolves round a pivot in the centre of a fixed board, an arrangement for inclining the model being provided.

The disturbing magnets and soft iron are arranged thus. For producing the semicircular deviation due to the hard iron of a ship thin magnets are placed as required in any of the grooves cut in the deck radiating from the centre of the compass, so that deviations due to any direction of the ship's head whilst building may be produced. For that part of the semicircular deviation due to soft iron a vertical soft iron bar is fixed in the central longitudinal line of the deck and near the stern. For the quadrantal deviation hollow cylinders of soft iron are placed under the deck similar to the rod e' of the figure. For the heeling error due to hard iron a magnet is placed vertically under the compass.

The correctors are magnets placed on the deck as $m'n'$, $m''n''$ in the figure, and soft iron spheres—on brass brackets which may be turned in azimuth round the compass—instead of the rods $e e$; a Flinder's or vertical soft iron bar before the compass; a vertical magnet under the centre of the compass to correct the heeling error.

This model is exceedingly well adapted for instruction and examination in the causes of the deviations generally found at standard compass positions in the mercantile navy, and the method of correction adopted in that service.

There remains now only the model made for the Bureau of Navigation of the United States Navy Department to be noticed. It consists of a miniature vessel of which the stem, keel, and stern-post are of bronze cast in one piece, with three wooden decks supported by bronze screws. This model, called the *Scoresby*, is pivoted at the stern by a socket in the floor, with a bronze wheel fitted under the bow, so as to be easily turned round in azimuth. The disturbing magnetic forces are produced by magnets and hollow wrought-iron tubes of soft iron, whilst wrought-iron plates can be attached to the sides of the vessel.

The *Scoresby* was designed with the object of proving by experiment the mathematical theory already noticed. Experiments were consequently made as to the effects of hammering the plates of the model with the bow in different directions, a magnetic survey being made after the hammering to determine the polarity in different sections, and its degree of permanency or otherwise. The model was next swung both when upright and inclined, for the deviations of the compass produced by a magnet or soft iron tube representing each parameter singly, combinations being made afterwards as desired. These experimental results proved satisfactorily the correctness of the mathematical theory.

This general description of the *Scoresby* will serve to show that the Americans have taken considerable pains in making valuable experiments in proof of theory, and for instruction to the seaman. Before parting with her, however, a quotation from the American professional paper on the subject of the *Scoresby* seems worthy of a place, as sounding a fresh warning note to those who ruthlessly distribute iron *ad libitum* and in any form round the position of a ship's standard or guiding compass.

"Compensation of large deviations by means of magnets is at the best but a remedy for an ailment; better not sow the seeds of the disease."

The three models just described have been selected as being the most modern specimens of these useful aids to knowledge, but there are others for the instruction of officers in the Royal Navy which have been in use for some years past. It will be gratifying to the many who take interest in maritime affairs to note the increasing anxiety for the spread of a sound knowledge of the principles of the magnetism of iron ships and the deviations of their compasses which the construction of these models manifests.

NOTES

THE total number of candidates for election into the Royal Society this year is sixty-two. Of these the following fifteen have been selected by the Council to be recommended to the Society for election; the voting will take place on June 4:—Shelford Bidwell, M.A., W. Colenso, F.L.S., H. B. Dixon, F.C.S., E. R. Festing, Major-Gen. R.E., Prof. A. R. Forsyth, M.A., Prof. A. H. Green, M.A., Prof. Victor Horsley, F.R.C.S., T. R. Lewis, M.B., R. Meldola, F.R.A.S., P. H. Pye-Smith, M.D., H. C. Russell, B.A., Prof. W. C. Unwin, B.Sc., R. Warington, F.C.S., Capt. W. J. L. Wharton, F.R.A.S., and H. Wilde.

THE following are the probable arrangements for the Friday evening meetings of the Royal Institution after Easter:—May 7, Mr. Frederick Siemens, "Dissociation"; May 14, Prof. John Millar Thomson, F.C.S., "Suspended Crystallisation"; May 21, Sir John Lubbock, Bart., M.P., F.R.S., "The Forms of Seedlings: the Causes to which they are due"; May 28, Prof. Oliver Lodge, D.Sc., "Electrical Deposition of Dust and Smoke"; June 4, Walter H. Gaskell, M.D., F.R.S., "The Sympathetic Nervous System"; June 11, Prof. Dewar, M.A., F.R.S.

THE editor of the *Sidereal Messenger* (U.S.) writes in his April number:—"We are glad to learn from private advices that a small observatory will soon be fitted up with the necessary instruments for continuous solar and local magnetic observation, in which daily solar photographs of the sun will form an important part of the work done by the observers. We are not aware that work of this kind is now anywhere systematically undertaken in the United States."

THE Congress of French Sociétés Savantes will take place as usual at the Sorbonne, and the final ceremony under the chairmanship of M. Goblet, the present Minister of Public Instruction. It is

expected that this ceremony will have an unusual interest, M. Goblet having sent a circular to the various learned Societies, announcing his intention of altering the date of the Convocation of French *savants* in Paris.

ALTHOUGH the Association Française and the Société Scientifique de France have passed a vote for their fusion into one compact body, the resolution has not been carried into effect, owing to some legal difficulties resulting from the very peculiar state of French law relating to Societies of public interest, which are considered as so many infants, whose properties are always in the hands of a lord chancellor for protection.

THE Report of the Committee of the Mitchell Library at Glasgow (where the Public Libraries Act was rejected by a moderate majority during the past year), while showing a largely-increased usefulness of that institution, forces attention to the very great cost of working even a reference library only. Out of an expenditure of 2770*l.*, only the odd 770*l.* can be employed in the combined purchase and cost of binding of both books and periodicals. Of this, 450*l.* is all that was spent in the purchase of 4500 publications; which does not suggest costly works for a reference library from which fiction is excluded. Nevertheless, the crowded state of the present rooms has led to an earnest effort to expend nearly fifty times that amount in a new site and "inexpensive" buildings, although the Committee are well aware that "a new and large building would imply a larger annual expenditure of every kind." The present premises have been much more economically, though not sufficiently, supplemented by the addition of two small houses adjoining, in one of which a reading-room for ladies has been fitted up, while the remaining rooms are well utilised by being shelved and filled with the less-used classes of literature. Complete sets of the 268 periodicals taken would be a valuable part of such a library if indexed in the American way, so that all the most recent information would be found there directly or indirectly. A presentation of 288 volumes from the Lords of Her Majesty's Treasury is specially acknowledged, and suggests that a gift from Government Offices of sets of their publications to all free libraries up to a certain time, which would be willing to properly house them, would be no very great cost to the nation, while it would be a reward to the enterprise of those towns which have organised free libraries and an encouragement to others to do so quickly.

THE Fish Commission steamer *Albatross*, *Science* states, arrived at Nassau, New Providence, March 19, after a most successful trip. The ship was chiefly engaged in making soundings. Two naturalists were landed at Watling's Island, San Salvador, where much valuable scientific material was gathered during a stay of two weeks. But little dredging has been done, so that few accessions of marine life have been made. At Rum Cay, Conception Island, Cat Island, and Great Exuma Island, the naturalists of the expedition obtained many valuable specimens of fish, lizards, birds' nests, eggs, cave relics, pottery, and about 500 bird-skins. These islands are very small and thinly populated. Vegetation is scarce, and the islands themselves are formed almost entirely of rock. Cocoa-nut trees and bananas are abundant, but oranges and apples rather scarce. The *Albatross* is now at Key West, and will spend some time dredging in the Gulf of Mexico and vicinity.

GENERAL HAZEN said recently, in his testimony before a U.S. Congressional Committee, that foreign signal stations were a necessity, and the establishment of a station in the West Indies had fully demonstrated this fact. It is quite probable that Congress will authorise the establishment of stations at important foreign points.

AN interesting discussion is just now being carried on between Scandinavian and German anthropologists as to priority in the theory of three great prehistoric periods—the ages of Stone, Bronze, and Iron. Dr. Sophus Müller, for the former, claims that the theory was first enunciated in 1837 by the Danish Thomsen, and that it was ridiculed for forty years by the Germans. To this Prof. Virchow, in the last *Zeitschrift für Ethnologie*, replies that Dr. Müller confounds two different things. The priority of the Stone Age to the others was never disputed in Germany; it certainly was denied that any epoch deserved especially the title of the Bronze Age, and he thinks that this was due to the propensity of the Scandinavians to exaggerate the extent of this epoch. But he contends that two Germans, Lish and Danneil, discovered the three ages simultaneously with Thomsen. In support of this he quotes a memoir by the former, published in 1837, but in large part printed in 1836, before Thomsen's work appeared, and when it was wholly unknown to him, expounding a similar theory. In 1835 Lish had actually arranged prehistoric objects in the Museum in Mecklenburg according to the three ages. Prof. Virchow therefore proposes that in future Danneil (whose share in the discovery does not appear so pronounced), Lish, and Thomsen should be regarded as the earliest propounders of the theory of the three prehistoric ages.

ON March 28, at about 9 p.m., a magnificent meteor was observed in several places between Trondhjem and Molde, on the north-west coast of Norway. An observer at the former town states that his attention was first attracted to the phenomenon by the street in which he was walking becoming suddenly brilliantly illuminated, and on looking up he saw a bright meteor, with a somewhat faint trail, going in a direction S.S.W. to N.N.W. The light from the body itself was an intensely bluish-white, and that of the trail grayish, with a red tint at the end. During its passage the meteor passed behind some light clouds, and was still visible through them, but not the trail. The meteor disappeared from view behind mountains, but a brightness could still be observed in that direction for some time afterwards. Another observer at Christiansund (about 130 kilometres south-east of Trondhjem in a straight line) states that he saw the meteor at that place at 8.45 p.m., going in a direction S.E. to N.W. It was about 40 centimetres in diameter, with a purple-coloured trail of about $1\frac{1}{2}$ metre in length, and its passage was accompanied by a whizzing sound like that of a flight of birds. The meteor illuminated the whole town brightly for some seconds, and burst with a report like that of a big gun. The light was so intense that even people in well-lighted rooms were attracted by the sudden brightness without. At Molde (about 60 kilometres further south) the meteor was also seen, and its bursting was so loud that the Romsdal Mountains returned a thundering echo.

IN the twenty-ninth issue of the Medical Reports of the Chinese Customs, published half-yearly, besides the reports of the medical officers at the various Treaty ports, which are probably of much professional and local interest, there are two special papers. In one of these the character and uses of the so-called "black-lime" of China are noted by Dr. Peek of Tientsin. This substance is generally stated (Dr. Williams even falls into the error) to be a kind of bitumen; it really is amorphous graphite, and it is used when mixed with lime to make a very hard and durable plaster, and it is also employed in dyeing cloth. The second special paper is Dr. Macgowan's on the movement cure in China, which has been already noticed in these columns.

THE Norwegian Meteorological Office is making an appeal to Norwegian sea-captains with reference to the total eclipse on August 29 next, viz. that any one who on that day happens to be in the locality where the eclipse is total shall make obser-

vations of the barometer and thermometer every quarter of an hour from 10 a.m. to 4 p.m. (Greenwich time), with a view to ascertain what the effect of the eclipse is on the atmosphere during totality, a point on which our knowledge is very limited. Proper forms for recording the observations, and full details of instructions, are issued gratis by the Office.

AT a recent meeting of the Russian Physical Society, M. B. Sreznewski pointed out some remarkable oscillations of the barometer during the series of atmospheric storms which had passed over Western Europe and Russia from December 12 to 17 last; namely, the sudden appearance on December 12 in Western Europe of a considerable barometric minimum in a region of very equally spread high atmospheric pressure; secondly, the very low range of the barometer at Nicholaistadt in Finland, as low as 717·6 mm.; and thirdly, the remarkable occurrence of a barometric minimum in Western Russia, which brings the author to conclusions similar to those which served M. Brownoff as a basis for his recently published theory of the movement of cyclones.

IN the month of January shocks of earthquake were felt in several parts of Sweden and Norway. The shock which we reported as having been felt in several parts of Central Norway on January 2 was also felt in several parts of Central Sweden. On January 21, at 9.55 p.m., another shock was felt in and around the town of Hernösand, on the Baltic, going in a direction east to west, and shaking houses and fixtures. On the following morning, at about 5 o'clock, another but fainter shock was felt in the same district. In one place two shocks were felt in quick succession.

A REPORT has been received from Tschembar, in Siberia, giving an account of some remarkable phenomena observed at that place on the night of January 3–4 last. At about 1 a.m. a meteor was suddenly seen rushing across the town, being accompanied by sudden gusts of wind, and bursting with a terrific report near the high-road outside the town, and killing a horse before a cart. The peasant who was driving it was so frightened that he was unable to give any details of the occurrence, believing that it was a "fire-dragon" which had slain his horse. Ten minutes later a loud report as of an explosion was heard, on which the commander of the garrison in the town ordered a patrol to proceed at once to the gunpowder magazine, as he believed it had been blown up. This official had hardly issued the order when a second and more terrific report was heard, accompanied by a violent vibration of the earth, which lasted half a minute. During the shock several houses fell in, and the thick ice on an adjacent lake was broken, the blocks being piled one upon the other. A shock and a similar report were observed at the same time at a town twenty versts distant.

ARRANGEMENTS are being made by the Canadian Commissioners at the forthcoming Colonial and Indian Exhibition to hatch and rear large numbers of Salmonidæ and other fish indigenous to the waters of Canada. Consignments of trout and whitefish ova have already arrived at the Exhibition, and are rapidly becoming incubated.

THE *Journal* of the Asiatic Society of Bengal, vol. liv. part ii. No. 3 (December 1885) contains two valuable papers on Indian entomology. Mr. E. T. Atkinson enumerates fifty-one species of Fulgoridæ (including the Indian lanthorn flies), of which several are indicated as new, and there are copious local (and other) notes on already known forms. Prof. A. Forel, who has paid so much attention to ants in general, enumerates twenty-six Indian species contained in the collection of the Calcutta Museum, with one or two new forms. The only other paper in the part is of a thoroughly practical nature, viz. by Mr. A. Pedlar "On the Cause of the Corrosion of Indian Tea Chests." The author sums up by stating that tea if properly cured has no power to corrode lead, but the corrosion is usually due primarily to acetic acid derived from the unseasoned wood of which the chests are too often made.

DR. MEYER has recently issued an "Album of Philippine Types" (Dresden, 1885), containing thirty-two photographic plates, with altogether about 250 figures of natives of Luzon and Mindanao, the two largest islands in the Archipelago. Some of these were originally taken by Dr. Meyer himself in the year 1872, when he spent some time in the Philippines; for the others he is indebted to Herr C. Heinszen, of Hamburg, Dr. W. Joest, of Cologne, and Dr. A. Schadenberg, of Glogau. Two plates with nine figures are devoted to the little-known Bagobos tribe of South Mindanao; all the rest to the motley populations of Luzon. Here are figured a large number of Negritos (Aetas) and half-caste Malayo-Negritos; Tinguianes, and Igorrotes from the northern and western districts; Ibilaos; Ilongotes from the province of Nueva Vizcaya, and Tagalas of every variety (pure, and half-caste Spanish, Chinese, and Negrito Tagalas) from Manilla and other districts. The accompanying letterpress gives a brief description of the several figures, the reader being referred for fuller information to Prof. F. Blumentritt's valuable treatise on the ethnography of the Philippines, which appeared in *Petermann's Mittheilungen*, Ergänzungsheft 67, 1882.

THE library of the Conservatoire des Arts et Métiers is to be lighted by electricity. It is the first Parisian library which will enjoy this advantage. The inauguration will take place next week, on the occasion of the meeting of the several scientific Congresses, which generally assemble in Paris during the week following Easter.

AT the January meeting of the Russian Chemical Society, Prof. Mendeléeff communicated some results of his investigation into the thermic effects of dilution of sulphuric acid with water. The maximum evolution of heat and the maximum contraction of 100 parts of the solution both correspond to the solution containing from 65 to 75 per cent. of H_2SO_4, which is very near to the hydrate $H_6SO_8 = S(HO)_6$. Together with some other observations this leads the author to the conclusion that there exist at least five more or less constant hydrates of sulphuric acid, as H_2SO_4, H_4SO_5, H_6SO_6, and two more containing a large amount of water, as $H_2SO_4 + 100H_2O$.

CONSIGNMENTS of grayling ova have been received by the National Fish Culture Association and the Buckland Museum. Considering the present period of the year, the fry are unusually late in becoming incubated, but this may be accounted for by the fact that, the past winter being very severe, it has greatly retarded the development of fish life. The ova are fully-eyed, however, and in some instances a few newly-born fish are issuing therefrom.

THE additions to the Zoological Society's Gardens during the past week include a Pudu Deer (*Pudua humilis*), five Chilian Sea-Eagles (*Geranoaetus melanoleucus*), two Siskins (*Chrysomitris barbata*), a Diuca Finch (*Diuca grisea*), two Auriculated Doves (*Zenaida auriculata*) from Chili, a King Vulture (*Gypagus papa*) from Tropical America, five Capoeira Partridges (*Odontophorus dentatus*) from Brazil, two Barn Owls (*Strix flammea*) from America, an Antarctic Skua (*Stercorarius antarcticus*) from the Antarctic Sea, presented by Mr. Harry Berkeley James, F.Z.S.; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*), a Barnard's Broadtail (*Platycercus barnardi*) from Australia, presented by Lord Braybrooke, F.Z.S.; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mr. W. Woods; six Field Frogs (*Rana arvalis*) from Breslau, presented by Mr. G. A. Boulenger, F.Z.S.; four Californian Quails

(*Coturnix californica*) from California, a Scarlet Ibis (*Eudocimus ruber*) from Para, deposited; a Roan Kangaroo (*Macropus erubescens*) from South Australia, an Eroded Cinixys (*Cinixys erosa*) from West Africa, a Merrem's Snake (*Liophis merremi*) from South America, purchased; an Axis Deer (*Cervus axis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

RELATION OF ASTEROID ORBITS TO THAT OF JUPITER.—Prof. H. A. Newton, in the *American Journal of Science*, April 1886, points out that the orbits of the asteroids should have a relation to that of Jupiter. For supposing the orbits of the asteroids to be distributed in any manner whatever, provided only that they make small angles with the plane of Jupiter's orbit, the action of Jupiter would give to each orbit a motion of its node which would differ for the different orbits, and eventually the orbits would come to be distributed somewhat symmetrically about the orbit of Jupiter. And as a matter of fact, the centre of gravity of the poles of the 251 known asteroid orbits, computed as for points of equal weight, lies only 30′ from the pole of Jupiter's orbit; so that the plane of Jupiter's orbit lies nearer to the mean plane of all the asteroid orbits than any single asteroid orbit does, the nearest orbits being those of Medusa and Euterpe, inclined to it 46′ and 49′ respectively.

In the same periodical Dr. H. Geelmuyden, of Christiania, remarks, relative to Prof. Searle's deduction that the plane of the zodiacal light has some relation to the asteroid orbits (NATURE, February 11, p. 350), that "the most northerly point of Jupiter's orbit has the heliocentric longitude 188°, or with 60° east elongation 178°; and for matter in the same plane, but nearer the sun, the approximation to coincidence with 160° is still greater."

THE PROPOSED CHANGE IN THE ASTRONOMICAL DAY.—M. Raoul Gautier has recently published in the *Archives des Sciences Physiques et Naturelles* of Geneva an account of the proceedings of the International Meridian Conference held at Washington in October 1884. Remarking that the resolutions passed at Washington are similar in many respects to those of the Roman Conference of the preceding year, M. Gautier goes on to point out how they differ in the important particular of the manner of reckoning universal time, and that on this account a large number of astronomers have expressed their reluctance to conform to these recommendations, more especially to the sixth resolution (which proposed that the astronomical and nautical days should be arranged everywhere to begin at mean midnight of Greenwich), the adoption of which would involve considerable changes in the astronomical and nautical ephemerides, which are used by all observers and navigators. Astronomers, M. Gautier states, as well as sailors, begin the day at noon; the former to avoid changing the date in the middle of the night during a series of observations, the latter because they find it convenient to commence the day at the moment when they observe the sun on the meridian. Why then, he asks with some force, oblige them to modify their habits, now of long standing, considering that the fourth resolution passed at the Washington Conference expressly stipulates that the universal day ought not to interfere with the use of local or other standard time where the latter appears desirable?

THE PLEIADES AS SEEN AND AS PHOTOGRAPHED.—MM. Henry have recently compared their beautiful photographic map of the Pleiades with the map so carefully laid down by M. Wolf in 1873-75, and published in vol. xiv. of the *Mémoires de l'Observatoire de Paris*, and find that the photograph possesses the following advantages over the map made by direct eye-observation. The photograph shows faint objects which are lost to the eye through their proximity to bright stars; thus the Maia nebula, and another near Electra, have been made evident, as well as details recognised hitherto only by Mr. Common in the Merope nebula. A number of faint companions have also been detected close to several of the brightest stars of the group, and in several cases where M. Wolf had detected a faint companion to a bright star, the photograph has shown that the magnitude of the former was under-estimated. Many more stars are seen on the photograph than are given in M. Wolf's map, the former showing 1421 stars, the latter 625; the aperture of the instrument employed being about the same in both cases. A yet more striking instance of the superior sensitiveness of the plate is seen in the fact that M. Rayet, in his revision of M. Wolf's map in the pure air of Bordeaux, and with a much more powerful instrument, added only 151 stars in a region where the photograph gave 338. All the stars observed by M. Wolf are seen in the photograph but ten, and these cannot be found in the sky.

The Brothers Henry, whilst laying stress on these facts as showing how indispensable a weapon photography has now become to the astronomer, disclaim the idea of criticising M. Wolf's great work, and completely assent to his opinion, expressed in the *Comptes rendus*, vol. cii., No. 9, that the eye of the observer must continue to work at the same time as the sensitive plate; the latter can never supersede the former.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 APRIL 25—MAY 1

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on April 25

Sun rises, 4h. 45m.; souths, 11h. 57m. 51·4s.; sets, 19h. 10m.; decl. on meridian, 13° 15′ N.: Sidereal Time at Sunset, 9h. 25m.

Moon (at Last Quarter April 26) rises, 0h. 57m.; souths, 5h. 28m.; sets, 10h. 2m.; decl. on meridian, 17° 22′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	4 16	10 37	16 58	3 29 N.
Venus	3 25	9 6	14 47	4 21 S.
Mars	13 19	20 21	3 23*	11 16 N.
Jupiter	15 20	21 37	3 54*	2 32 N.
Saturn	7 51	16 3	0 15*	22 51 N.

* Indicates that the setting is that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich)

April	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
28	e¹ Aquarii	6	3 38	4 42	42 288
29	78 Aquarii	6	2 49	3 8	139 175

April	h.	
28	6	Mercury at greatest distance from the Sun.
29	17	Venus at greatest elongation from the Sun, 46° west.
30	5	Venus in conjunction with and 0° 19′ north of the Moon.

Positions of the Comet Fabry

1886	R.A. h. m. s.	Decl. ° ′	Log Δ	Brightness.
April 25	1 45 25	31 18 N.	9·420	315
27	2 29 43	24 51	9·355	400
29	3 20 22	15 22	9·309	465

Positions of the Comet Barnard

1886	R.A. h. m. s.	Decl. ° ′	Log Δ	Brightness.
April 25	1 39 50	39 53 N.	0·047	67
27	1 38 41	40 19	0·023	80
29	1 38 8	40 31	9·997	94

The comet positions are for Berlin midnight.

Variable-Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
R Leporis	4 54·4	14 59 S.	Apr. 26,	0 0	*m*
δ Libræ	14 54·9	8 4 S.	,, 25,	3 26	*m*
U Coronæ	15 13·6	32 4 N.	,, 30,	1 53	*m*
U Ophiuchi	17 10·8	1 20 N.	,, 25,	1 31	*m*
			and at intervals of	20 8	
X Sagittarii	17 40·4	27 47 S.	Apr. 28,	2 20	*m*
			May 1,	0 0	*M*
W Sagittarii	17 57·8	29 35 S.	Apr. 25,	21 40	*m*
			,, 29,	2 25	*M*
U Sagittarii	18 25·2	19 12 S.	,, 26,	2 30	*m*
			,, 29,	2 20	*M*
β Lyræ	18 45·9	33 14 N.	,, 29,	21 35	*M*
η Aquilæ	19 46·7	0 7 N.	,, 29,	21 40	*M*
R Vulpeculæ	20 59·3	23 22 N.	,, 25,		*m*
δ Cephei	22 24·9	57 50 N.	May 1,	0 0	*M*

M signifies maximum; *m* minimum.

Meteor Showers

The principal shower of this week is that of the *Aquarids*, radiant R.A. 326°, Decl. 2° S. It is a strong shower, visible just before daybreak, from April 29 to May 2.

GEOGRAPHICAL NOTES

THE Geographical Society of Paris held last Friday its first general annual meeting. M. de Lesseps was in the chair, and delivered an address on the Panama Isthmus and Canal. Amongst the gold medallists are MM. Capello and Ivens, the Pandit Krishna, and Alfred Marche.

M. PELLET, a French explorer belonging to the cavalry, was murdered by an unfaithful guide on his way to Timbuctu, before reaching Insalah, the capital of Tuat.

THE Portuguese Legislature has, at the initiative of the Geographical Society of Lisbon, passed an act relating to MM. Capello and Ivens, of which the following are the main provisions:—(1) They are to receive a pension of 600,000 *reis* (135*l*.) per annum each, in addition to a similar pension granted to them after their first journey; (2) exemption from all taxes; (3) the Treasury is to bear the expense of printing an edition of the account of their last African journey, of which 5000 copies will be given to them, and the copyright will be their property; (4) confirmation of the rank conferred on them, and dispensing with the condition of serving the remainder of the term in Africa in consideration of which the rank was granted to them by law. Portugal, it would thus appear, knows how to honour officially, as a nation, her sons who have done honour to her. MM. Capello and Ivens's work is in the National Press at Lisbon, and the first volume is expected to be published in two months.

THE current number (Band v., Heft 1) of the *Mittheilungen* of the German African Society is full of interesting matter. The contents are divided into two parts: (1) the reports of the Society's explorers in the Congo region, and (2) those in the Western Soudan. The first part contains Dr. Büttner's diary of his journey during July, August, and September last year. Leaving Arthington Falls on July 3, he travelled eastward to the Quango, at its junction with the Quilo, which point he reached on the 21st of the same month. He then turned south along the right bank of the Quango for seven days, as far as Muene Putu, where he stayed for a fortnight, again returning northward, and crossing to the left bank near the spot where the Quilo joins it. Leaving this on August 21, he continued down the left bank to Kiballa, whence he turned westward to Stanley Pool. A map compiled by Dr. R. Kiepert accompanies the diary, and also tables of various measurements calculated by Dr. von Danckelman. The reports from the Expedition in the Western Soudan are written by Dr. Flegel (from Bakundi, on the Tarabba) and Dr. Semon.

THE last number of the *Mittheilungen* of the Geographical Society of Vienna, like so many similar publications just now, is mainly devoted to African geography. It contains, with a description, routes, &c., a map of the neighbourhood of Ango-Ango, by Herr Baumann, a member of Dr. Lenz's Austrian Congo Expedition. The topographical material was collected during a stay at Ango-Ango, and was put together in Vienna. Two further letters from Dr. Lenz are also published: the first describes the journey from Ngombe to Stanley Pool, and the second the journey to the Equator Station on the Upper Congo. It is satisfactory to learn that the Expedition reached this point in excellent health, and that the Free State officials gave it every assistance. The only other paper in the number is the conclusion of Dr. Diener's contribution to the geography of Central Syria. At the end he confesses that it is at present impossible to say whether the physical features of a great part of this region have altered since the days of the Romans. There are facts, historical, climatic, and geographical, which tend in favour of both sides, and the problem is one for solution in the future.

ACCORDING to a recent communication of M. Venukoff to the Geographical Society of Paris (to which we have already referred), the results of a survey of the basin of the Neva, executed in 1884-85, show that hitherto the levels generally accepted by geographers here have been totally incorrect. The following is a comparison of the levels now ascertained with those given by M. Reclus in his "Géographie Universelle" for Lakes Ladoga, Onega, and Ilmen:—

	New Survey	M. Reclus
Ladoga ...	5·01 metres ...	18 metres
Onega ...	34·97 ,, ...	72 ,,
Ilmen ...	17·97 ,, ...	82 ,,

These figures, and others which might be quoted, show that the region watered by the Neva and its tributaries is much lower than was generally supposed. The new figures refer to the normal zero of Cronstadt, which is itself 0·66 m. above the level of the Baltic at Revel. The absolute heights of the lakes is thus slightly increased, but still the differences between the old and the new figures are very great. As the results of the new survey appear unquestionable, the former hypsometric details respecting the basin of the Neva must be dismissed as wholly incorrect.

THE French Topographical Society proposes that an International Exhibition of Topography should take place in the Palais de l'Industrie next year, under the patronage and with the assistance of the Government. The Committee of Organisation which has been appointed has addressed a circular to French topographers, geologists, geographers, and explorers, asking for their co-operation. The Society, the circular says, has for its aim the popularisation of the science of topography, especially by means of gratuitous lectures, and it is anticipated that an exhibition will give a spur to this work.

SOME RESULTS OF OBSERVATIONS WITH KITE-WIRE SUSPENDED ANEMOMETERS UP TO 1300 FEET ABOVE THE GROUND IN 1883-85

SINCE I had the honour of reading a paper on the first series of observations taken in 1883-84 before the Association in Montreal last year, I have made twenty-five fresh observations at heights above the ground varying from 300 to about 1300 feet, or double the greatest height before attained. I had hoped in have been able to make a greater number and variety of observations, but a pressure of private and other work has stood to the way.

Since, however, in ten of the new observations the upper anemometer was suspended at a height of over 1000 feet above the ground, or 1500 feet above the sea, I trust the results may be thought sufficiently novel and valuable to merit the brief discussion to which I have subjected them.

In dealing with the observations I have included fifteen of those made in 1883-84, and have thus been able to utilise forty observations in all. As the observations were intentionally made as nearly as possible at certain desired heights, so as to afford a regular progression upwards in the scale of height, I have been able to arrange forty-two pairs of observations at two different levels in six groups.

In order to present the results in a form in which they can be readily compared, as well as to exhibit the law of change of the velocity with the height, I have computed for each observation the value of the corresponding exponent in the empirical formula $\frac{V}{v} = \left(\frac{H}{h}\right)^x$, where V, v, H, h, are the velocities and heights of the upper and lower instruments respectively. The several groups, together with their corresponding heights, mean velocities, and exponents, are given in the following table:—

TABLE I.

Group	No. of observations	Mean height of upper instrument above ground, in feet	Mean height of lower instrument above ground, in feet	Mean height of both	Mean velocity at both heights in feet per minute	Mean upper and lower velocities: Upper	Lower	Mean value of x
*1	7	250	102	176	1395	1617	1174	0·372
2	3	322	128	225	1955	2232	1679	0·307
*3	8	407	179	293	1545	1705	1385	0·275
4	5	549	252	400	1940	2107	1773	0·237
5	9	795	481	638	2074	2192	1957	0 250
6	10	1095	767	931	2166	2236	2096	0·194

The general and obvious conclusion to be drawn from this table, as well as from the individual observations (in which a reverse case has never occurred), is that the velocity of the wind

* These two groups comprise observations made in 1883-84 only. The other groups those made in 1884-85 only.

TABLE II.—*Exponents in Formula* $\frac{V}{v} = \left(\frac{H}{h}\right)^x$ *arranged for Different Mean Velocities in all 6 Groups. Groups and Values of x with the Corresponding Mean Resultant Directions D**

Range of mean velocities in feet per minute	1	D	2	D	3	D	4	D	5	D	6	D
700 to 1100	·422 (1)	N. 85 W.	—	—	·343 (2)	N. 39 W.	—	—	·576 (1)	N. 43 W.	·279 (1)	N. 43 W.
1100 to 1500	·345 (5)	S. 83 W.	—	—	·376 (2)	S. 14 W.	·290 (1)	N. 59 E.	·235 (1)	S. 26 W.	—	—
1500 to 1900	·440 (2)	S. 22 W.	·286 (1)	S. 63 E.	·156 (2)	N. 61 W.	·290 (2)	S. 22 W.	·214 (1)	N. 39 W.	·290 (1)	N. 71 W.
1900 to 2300	—	—	·317 (2)	N. 19 W.	·225 (2)	S. 21 W.	—	—	·212 (2)	N. 24 W.	·196 (5)	S. 80 W.
2300 to 2700	—	—	—	—	—	—	·158 (2)	N. 53 E.	·237 (3)	N. 16 E.	·239 (1)	N. 40 E.
2700 to 3100	—	—	—	—	—	—	—	—	·091 (1)	N. 57 E.	·077 (2)	N. 57 E.
Mean range of exponent for 400 feet of velocity. + if it varies directly with velocity, − if it varies inversely with velocity	+ ·009		+ ·031		− ·039		− ·033		− ·097		− ·040	

TABLE III.—*Exponents in Formula* $\frac{V}{v} = \left(\frac{H}{h}\right)^x$ *arranged for the Different Hours of the Day during which the Instruments were suspended, together with the Mean Velocities (V′) and Directions (D) of the Wind†*

HOURS	GROUP 1 x	D	V′	GROUP 2 x	D	V′	GROUP 3 x	D	V′	GROUP 4 x	D	V′	GROUP 5 x	D	V′	GROUP 6 x	D	V′
11 to 12	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	·058 (1)	N. 57 E.	2703
12 to 1	·360 (1)	S. 8 E.	1447	—	—	—	·163 (1)	N. 48 W.	1635	—	—	—	—	—	—	·174 (2)	N. 7 W.	2286
1 to 2	·360 (1)	S. 8 E.	1447	—	—	—	·163 (1)	N. 48 W.	1635	—	—	—	—	—	—	·154 (3)	N. 31 E.	2286
2 to 3	·360 (1)	S. 8 E.	1447	—	—	—	·163 (1)	N. 48 W.	1635	—	—	—	·235 (1)	S. 26 W.	1368	·087 (2)	N. 60 E.	2494
3 to 4	—	—	—	·307 (3)	N. 45 E.	1956	·257 (5)	N. 75 W.	1580	·119 (1)	N. 39 E.	2378	·163 (4)	N. 61 E.	2183	·116 (4)	N. 41 W.	2479
4 to 5	·386 (4)	S.	1521	·332 (2)	S. 17 W.	1889	·263 (6)	S. 89 W.	1546	·183 (2)	N. 36 W.	1945	·240 (8)	N. 22 W.	1997	·185 (7)	N. 70 W.	2129
5 to 6	·335 (5)	S. 34 W.	1348	·286 (1)	S. 63 E.	1609	·342 (4)	S. 18 E.	1460	·237 (5)	N. 78 E.	1940	·252 (8)	N. 13 W.	2162	·192 (8)	N. 41 W.	2188
6 to 7	·315 (3)	S. 45 W.	1284	·286 (1)	S. 63 E.	1609	·414 (2)	N. 82 E.	1203	·237 (5)	N. 78 E.	1940	·251 (7)	N. 13 E.	2194	·215 (6)	N. 48 W.	2099
7 to 8	—	—	—	—	—	—	·458 (1)	S. 23 E.	1402	·204 (2)	N. 49 E.	1884	·328 (1)	N. 49 E.	2691	—	—	—
Ranges of exponents and velocities	− ·071		− 237	− ·046		− 280	+ ·295		− 233	+ ·118		− 438	+ ·165		+ 508	+ ·128		− 395

+ if increasing, − if decreasing, towards evening ; ═ signifies maximum, — minimum.

* The resultant wind directions when calculated from more than two observations have been derived by means of Lambert's formula.

† The resultant wind directions are calculated by Lambert's formula.

always increases from the surface of the ground up to 1800 feet above sea-level, and that the ratio of the increase steadily diminishes up to that height. The only exception to the steady decrease in the value of x occurs in Group 5, and this is evidently due to the inclusion in that group of an abnormally large value of x (0·576), corresponding to an equally abnormally small velocity of 789 feet per minute, which is little more than a third of the mean velocity of the stratum corresponding to that group. The mean velocities of each group are also seen to increase with some degree of regularity with the height, but this is, of course, partly accidental. In estimating the value of the exponent x for strata of the atmosphere at different heights above sea-level, it must be remembered that the place of observation is 500 feet above sea-level, and therefore that at a certain height above the ground the motion of the air in all probability approximates to what it would have at its real height above the sea. Where this state of things *actually* occurs, we have no ready means of determining, but at a height of 1000 feet above the ground we may assume that the influence of the subjacent tableland is almost obliterated, and the motion of the air *approximates* to what it would have at its real sea-level height. On this assumption, if we add the full 500 feet to each height in Group 6, we get the following value for the exponent :—

	Upper sea-level height	Lower sea-level height	Value of x
Group 6	1595	1267	0·28

If more reasonably we add 400 feet only, we get $x = 0·26$, or almost identically the same value as 0·25, which I found agree best on the average with Dr. Vettin's cloud observations at Berlin, ranging from 1600 to 23,000 feet above sea-level (NATURE, January 11, 1883). I think, therefore, that the results of the present series of observations may be taken to add strong confirmation to the general agreement of the empirical formula $\frac{V}{v} = \left(\frac{H}{h}\right)^{0·25}$, with the average motion of the air at heights over 1600 above sea-level.

One great advantage which results from the representation of the observations in the form of exponents is that we are thus enabled to compare observations differing from one another, both as to height and velocity, in a manner which would otherwise be almost impossible.

There are four principal variables which have been observed, and which are likely to affect the value of these exponents, viz. (1) the mean velocity at the upper and lower elevations; (2) the direction of the wind; (3) the time of day; and (4) the month of the year. I have, so to speak, differentiated the exponents with respect to each of these variables in turn, and have in each case placed the corresponding values of the other variables alongside, in order to see how much of the resulting variation of the exponent is independent, or dependent on accidental collocations of the other variables. The results I find most curiously involved, owing to apparently accidental groupings of some of the variables.

One or two variations can, however, be shown to arise from the influence of one factor alone, after that due to the co-existence of others is allowed for. One of these is that due to the change of mean velocity, and the other is the diurnal change with the hour of the day. These are shown in the accompanying Tables II. and III. respectively.

In Table II. the exponent is found, on the whole, to increase with an increase in the velocity in the two lowest groups (1 and 2), and to decrease in the four upper groups, the maxima in each of these groups occurring at the lower velocities, and the minima at the highest ones.

This latter result is what might have been expected *a priori*, and though the first two groups would appear at first sight to present an anomaly, it must be remembered that in these groups the lower instrument is hardly above the influence of surrounding trees, so that in high winds, while the upper instrument might be feeling the full force of the wind, the lower one might be unduly sheltered from it by adjacent trees or buildings.

In Table III. the diurnal variation in the value of the exponents, reaching its minimum from 2 to 3 or 3 to 4, and its maximum between 6 and 8 (as far as the observations go), is most clearly and regularly shown in each of the four upper groups, and as these last are well beyond the influence of local obstructions, I regard the uniformity with which they exhibit this variation as a strong proof in favour of its physical existence independently of any similar variation caused by the parallel march of other factors. Even if part of the variation in groups 3, 4, and 6 is due to the equally regular decrease in the mean velocity from midday to evening, it can be shown from Table II. that this only accounts for a portion of the observed variation.

Thus, taking the ranges of the exponents in Table III., and adding to or subtracting from them the proportional ranges of the exponents for the corresponding opposite range of velocity (deduced from the mean range of the exponents for 400 feet range of velocity in Table II.), we get the following results :—

Ranges of exponents from diurnal minimum to diurnal maximum: + increasing towards evening; − decreasing towards evening.	Groups	1	2	3	4	5	6
		−·065	−·025	+·273	+·083	+·286	+·088

that is to say, for Group 5 the variation is increased, and for the rest not materially diminished.

The opposite variation in the two lowest groups (1 and 2) may be capable of an explanation somewhat analogous to the similar anomaly presented by these two groups in Table II., but in any case it cannot be said either to sensibly corroborate or invalidate the physical existence of the variation so statistically marked in all the four upper groups.

This diurnal change in the value of the ratio of the velocity of the upper to the lower strata which is here shown to occur for the afternoon hours, is confirmed by various other casual observations, and is in complete accord with the results afforded by anemometrical observations on Ben Nevis and other lofty mountain observatories, as well as with Dr. Köppen's theory of the diurnal period in the surface-wind alluded to in my former paper.

Since at stations near sea-level the diurnal wind-velocity reaches its maximum at midday and its minimum at midnight, while at lofty stations about 4000 feet above sea-level the critical epochs are reversed, it is evident that somewhere between these levels a neutral plane exists where the diurnal variation is *nil.* The ratio of the upper velocity to the lower for a given difference of height would, however, continue to vary diurnally all the way up (unless some unknown law intervene), reaching its minimum value about midday and its maximum about midnight.

Indications of other laws have been noticed in the value of the exponents, such as a maximum for west winds and a minimum for east winds in five out of six of the groups, and also a maximum in the autumn, minimum in the winter, and maximum again in the summer in all the groups, but the observations are too few and the factors too involved to establish these with any certainty. I trust on a future occasion to be able to go into these questions more in detail, and also to supply the morning half of the diurnal variation, which I consider to be the most certain and valuable result I have as yet obtained in addition to the law of the general progressive decrease in the value of the exponent up to 1800 feet above sea-level in the *free* atmosphere.

E. DOUGLAS ARCHIBALD

BASIC CINDER[1]

THE interest of this report centres principally around the question of the manurial value of undissolved phosphates present in basic steel slag or cinder. The basic cinder is the effete and broken up basic lining of the converters used in the Thomas and Gilchrist process for dephosphorising iron, and is made in very large quantities as a by-product of steel manufacture. It contains from 16 to 19 per cent. of phosphoric acid in union with lime and other bases in combinations insoluble in water.

At the request of the North-Eastern Steel Company Prof. Wrightson and Dr. Munro undertook field experiments in order to test the manurial value of this substance. These experiments were carried out last summer on the College farm at Downton, and at East Howle, Ferry Hill, county of Durham, upon dissimilar soils, and under different climatic conditions. The results as given in the very concise report before us are remarkable, and certainly must be highly satisfactory to those who are interested in the future of basic cinder. The value of this substance as a fertiliser for swedes and turnips, as well as for grass, is placed beyond reasonable doubt by a most remarkable unanimity of results obtained at both experimental stations. Each series

[1] "Report on Experiments made to test the Manurial Value of Basic Cinder from the North-Eastern Steel Works." By Prof Wrightson and Dr. Munro, of the College of Agriculture, Downton, Salisbury. Middlesbrough: *Daily Exchange* Offices, 1886.

was composed of thirty-five plots of one chain square, or of one-tenth of an acre each, and comprised forty drills or rows of plants. The plots were arranged to form five rows of seven plots each, and a rectangle of three and a half acres. They were so disposed within this area that every manured plot was adjacent to an unmanured plot, with the object of obtaining repeated confirmations of any differences which might be indicated in favour of the dressings. Every trial was made in duplicate in both series, and the results are graphically shown by tinted plans, on which the number of the plot, the manurial dressing used, and the number and weight of roots grown are printed.

Not only do these experiments prove ground basic cinder to be a valuable fertiliser, but they assign it a higher position than ground coprolite, and place it only slightly below "superphosphate" in value. This remarkable result is, we find, supported by statements resting on the authority of Dr. Biedermann *Centralblatt* (vol. xiv. part 2), in which the phosphoric acid in basic cinder is asserted to be more readily appropriated by growing plants than is the phosphoric acid contained in coprolites.

The subject is full of interest as bearing upon the positive profits of steel manufacture, and also upon the manufacture of superphosphate and upon agricultural practice. It has attracted the attention of M. Grandeau, of the Faculty of Science of the French University, who contributed a review of the pamphlet before us occupying over three columns of *Le Temps* newspaper. In the course of his remarks he says:—"Les résultats obtenus en Angleterre confirment pleinement, on le voit, ceux que les agronomes allemands ont publiés et que j'ai précédemment analysés. Les scories de déphosphoration sont appelées à jouer un rôle considérable dans la fumure du sol. Des négociants ont déjà traité avec quelques-unes des importantes usines de l'Est (Alsace-Lorraine notamment) pour l'achat de toute leur production de scories."

The experiments conducted at Downton and Ferry Hill were not only instituted to ascertain the positive value of ground basic cinder in comparison with unmanured plots. In them the ground cinder was compared with ground coprolite, with ordinary superphosphate, with a rich superphosphate, with a superphosphate made direct from the basic slag, and with a superphosphate to which green vitriol was added. The subject is likely to arouse a very considerable amount of attention.

AN IMPROVED FORM OF TEMPERATURE REGULATOR

IN 1882, at the request of the Board of Trade, the Royal Society appointed a Committee, consisting of Sir G. Airy, Col. Clark, and Prof. Stokes, to advise on the question of improving the existing means of the comparison of standards of length at the Standard Office. In their report the Committee suggested improvements in the arrangement for securing greater uniformity and steadiness of temperature in the bars under comparison. As a first step in this direction, the Cambridge Scientific Instrument Company were requested to investigate the subject of temperature regulators, and to consider the general design of a comparing apparatus. They proposed that the standards, some hours before they were observed, should be placed in metal cases and immersed in a bath containing water; and that they should not be disturbed during the process of observation. If the uniformity of temperature of the water could be ensured, it would secure the equality of temperature of the standards and remove one of the greatest difficulties in the construction of a satisfactory comparing apparatus.

After some preliminary trials a regulator was constructed similar to that used at the Bureau International des Poids et Mesures at Sèvres.[1] Its action depends on the variation of pressure of a saturated vapour, caused by a change of temperature. The pressure on the volatile liquid and vapour is due to the atmosphere, as well as to a column of mercury; consequently the regulated temperature will vary with any change in the atmospheric pressure. In the following experiments the corresponding change of temperature for one inch alteration of the barometer was about 0°·37 C. The accuracy of the regulator therefore depends on the constancy of the atmospheric pressure, and to overcome this serious disadvantage an arrangement was devised for maintaining a constant pressure on the volatile liquid.

[1] See "Travaux et Mémoires du Bureau International des Poids et Mesures," tome i. p. C. 10.

An iron bath, D (Fig. 1), containing water, was placed in a wooden box. The intermediate space was filled with sawdust; this was done to minimise the unequal cooling due to the varying temperature of the room. The two ends of a U-shaped tube were fixed into the bottom of the iron bath and passed through holes in the side of the wooden box. The water was kept warm by means of two gas-flames placed under a part of this tube. One of the gas-flames was connected to the regulator and the other direct to the gas-main. The object of the second flame was to re-light the regulated gas-jet in case it should have been extinguished by the regulator.

The water in the bath was kept thoroughly stirred by air forced through it by means of bellows. These were placed inside the box in order to keep them warm, and also for the more important reason of avoiding the currents of air which would otherwise be produced at each stroke. The air used for

Fig 1

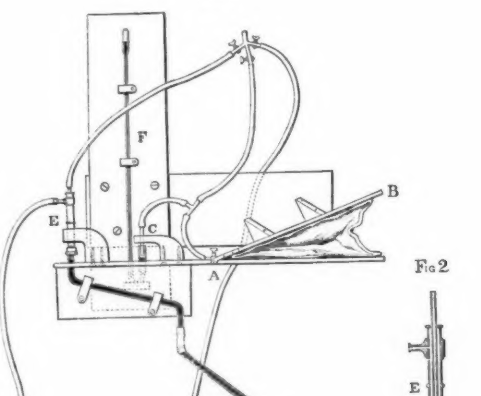


Fig 2

stirring was thus saturated with aqueous vapour, and did not cool the water in the bath by absorbing moisture from it. The nozzle of the bellows was connected to the U-shaped tube by a branch inserted just above the point where the gas-flame was applied. The air thus pumped through the upper part of the U-tube caused a rapid circulation of water through it. This method has the advantage of applying the heat in a manner which does not tend to make the water in one part of the bath perceptibly hotter than the rest.

The volatile liquid in the regulator was a mixture of methyl-chloride and ethyl-chloride, boiling at about 2½° C. under the normal atmospheric pressure. It was contained in a flat bulb, G, blown at the end of a glass tube, and was under a head of mercury. The glass tubes containing the mercury were connected by short lengths of canvas-lined india-rubber tube. A double brass tube was secured to the open end of the regulator, E; this is shown enlarged in

Fig. 2. The gas entered by the inner tube, which passed down to the surface of the mercury, and the outer tube was connected with the gas-burner placed under the U-shaped heating-tube. Thus a rise of mercury in the regulator reduced the supply of gas to the burner. The cross-section of the flat glass bulb at the common surface of the mercury and volatile liquid was large compared with the cross-section at the upper end of the regulator; thus nearly all the increase in height due to expansion of the volatile liquid and vapour takes place at the upper end of the regulator, and the level of the common surface of the mercury and volatile liquid remains nearly constant.

The most interesting part of the apparatus is the arrangement for compensating for the variation of atmospheric pressure. With this object a barometer in the form of a bent tube is fixed at F. To simplify the explanation we will suppose that the atmospheric pressure diminishes by an amount equal to a head of one inch of mercury; this will cause the mercury in the open end of the barometer to rise half an inch. If the regulated gas-flame is to be extinguished when there is a constant pressure on the volatile liquid, then the tube E must be raised one inch; thus it must move in the same direction as and twice the amount of the exposed surface of the mercury in the barometer. To accomplish this the upper part of the regulator was attached to a board turning about a horizontal axis, A. A gas-bag was placed between the projecting end of this board and a fixed board, B. The board turning about A was so weighted as to tend to close the bag. The nozzle of the bag was connected to the gas-main, and a branch pipe led to a small tube, C, passing down the open end of the barometer. This small tube was fixed by a bracket to the movable board half-way between the upper end of the regulator and the pivot A. Now if the mercury rises in the open end of the barometer it closes the tube C, and the gas from the main passes into the bag, forces the boards apart, and raises both the upper end of the regulator and the tube C, until the escape restores the equilibrium. The flexible india-rubber connections in the glass tubes allow the necessary movement to take place. This arrangement is of interest, as the pressure of the gas-supply is the motive-power for automatically moving a piece of mechanism in a required manner.

The apparatus was kept in action for fourteen days without readjustment, but the stirring of the water was discontinued at night. The thermometer was read about ten times a day, and from July 18 to August 1 the extreme readings were 30°·90 C. and 30°·86 C. The greatest change of temperature during any day was 0°·04 C., the least observed change during any day was 0°·01 C., and the longest period during which no change was observable was from 12.30 p.m. on July 20, to 1 p.m. the following day. At night, when the stirring was discontinued, the variation of the temperature was greater, but it settled down to its normal amount shortly after the stirring began. In a properly-constructed comparing-room the change of temperature would have been less. On one occasion the barometer rose rapidly, nearly half an inch in twenty-four hours, and during this time the temperature of the water did not vary perceptibly. If the barometer had not been attached to the regulator, this change of pressure on the volatile liquid would have produced a change of 0°·14 C. in the bath.

The apparatus was roughly made in an experimental form, but the results were highly satisfactory. There were no doubt errors in the readings of the thermometer. Sir William Thomson, in his article on "Heat" in the "Encyclopædia Britannica," describes an error which may be introduced owing to the mercury in the stem of a thermometer remaining at rest whilst slight changes of temperature are occurring, and then moving suddenly into a new position, where it again remains at rest. This phenomenon was observed in the very delicate thermometer used.

The variation of temperature due to the expansion of the mercury in the barometer and regulator was perceptible, and agreed roughly with the amount arrived at by calculation. Very small errors were also probably introduced by the following causes: the sticking of the mercury in the regulator and the barometer; variation of the gas-pressure; imperfections in the mechanism and of the vacuum in the barometer. There can, however, be little doubt that the errors produced by these and other causes could be reduced to an inappreciable amount, and if the apparatus were placed in a room of fairly constant temperature, remarkable results could be obtained.

HORACE DARWIN

SCIENTIFIC SERIALS

Journal of the Russian Chemical and Physical Society, vol. xviii., fasc. ii.—On the analysis of platinum ores, by F. Willm. All former methods of the separation of noble metals, though sufficient for technical purposes, are considered not exact for the scientific determination. Electrolytic method is recommended.—On the thermic effects of the replacement of hydrogen by bromine in the aromatic compounds, by E. Werner.—On cholanic and bileanic acids, by P. Latchinoff. Both having been obtained from cow's bile and formulæ proposed for the former $C_{25}H_{38}O_7 + \frac{1}{4}H_2O$, and for the latter $C_{25}H_{36}O_8 + \frac{1}{4}H_2O$.—Contribution to the theory of the influence of the decomposition of a body due to heat or to mechanical influences, on its magnetism, by P. Bakmetieff.—Thermo-electrical researches, by the same author. The starting-point for these researches being the fact observed by the author, that the thermo-electro generative force in the metal rods, which serve as thermo-elements, undergoes variations under the influence of the contraction or expansion of the rods parallel to those of magnetism in the same metals and from the same causes.

Rendiconti del Reale Istituto Lombardo, February 18.—State of public instruction in Italy, by Prof. A. Amati. In general the results here tabulated of an inquiry into the present state of instruction throughout the peninsula show that the number of unlettered is in direct proportion with that of the criminal classes.—On a phenomenon of intermission in the sense of hearing, by Prof. A. Raggi. It is shown that under certain conditions regularly recurring sounds strike the auditory faculty in rhythmically recurring waves of greater and less intensity. The phenomenon is regarded as the direct result of perception, the reflex act represented by the awakened attention not being produced with a uniform degree of energy continued throughout the duration of the stimulus, the lack of uniformity being itself due to the feeble degree of excitement.—Note on a simple and obvious, but not hitherto noticed deduction from Taylor's formula in infinitesimal analysis, by Gian Antonio Maggi.—Remarks on a normal metamorphosis of the scented violet due to the presence of the larva of *Cecidomyia destructor*, by Dr. S. Calloni.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 25.—"On the Changes produced by Magnetisation in the Length of Iron Wires under Tension." By Shelford Bidwell, M.A., LL.B. Communicated by Prof. F. Guthrie, F.R.S.

In a paper communicated to the Royal Society about a year ago, the author discussed the results of certain experiments made by Joule in relation to the effects of magnetism upon the dimensions of iron and steel bars.

It is well known that the length of an iron rod is in general slightly increased by magnetisation. Joule enunciated the law that the elongation is proportional in a given bar to the square of the magnetic intensity, and that it ceases to increase after the iron is fully saturated. The author's experiments, made with a greater range of magnetising forces and with thinner rods than those used by Joule, showed that if the magnetising current were gradually increased after the so-called saturation point of the iron had been reached, the elongation, instead of remaining at a maximum, was diminished, until, when the current had attained a certain strength, the original length of the rod was unaltered, and if this strength were exceeded, actual *retraction* was produced.

Joule also found that when the experiment was performed upon an iron wire stretched by a weight, the magnetic extension was in all cases diminished, and if the weight were considerable, magnetisation caused retraction instead of elongation. From these facts he appears to have formed the conclusion that, under a certain critical tension (differing for different specimens of iron, but independent of the magnetising force), magnetisation would produce no effect whatever upon the dimensions of the wire. In one of his experiments a certain iron wire loaded with a weight of 408 lbs. was found to be slightly elongated when magnetised; the weight was then increased to 740 lbs., with the result that magnetisation was accompanied by a slight retraction. In both cases the magnetising currents varied over a considerable range, and the smaller ones were without any visible effect. Commenting upon these results, Joule conjectured that "with a tension of about 600 lbs. (which number is roughly

the mean of 408 and 740) the effect on the dimensions of the wire would cease altogether in the limits of the electric currents employed in the above experiments."

In reference to this surmise the author in his paper of last year expressed his belief that, if Joule had actually made the experiment, he would have found that the length of the wire was increased by a weak current, that a current of medium strength would have had no effect whatever, and that one of his stronger currents would have caused the wire to retract. He had, in fact, reason to believe that the effect of tension was to diminish the "critical magnetising force" (which produces

		Commercial iron wire, diam. 1·2 mm.				Charcoal iron strip, section 3 mm.				Hard wire, diam. 2·6 mm.		Soft wire, diam. 3·25 mm.	
Stretching load ...		3 lbs.	7 lbs.	10 lbs.	14 lbs.	3 lbs.	7 lbs.	10 lbs.	14 lbs.	3 lbs.	14 lbs.	3 lbs.	14 lbs.
Smallest current producing sensible elongation	Amperes	0·043	0·064	0·084	...	0·033	0·020	0·029	0·064	0·12	0·15	0·064	0·033
Current producing maximum elongation	Amperes	0·49	0·39	0·23	...	0·44	0·33	0·27	0·15	0·70	0·58	0·70	0·58
Current by which original length is unaffected ...	Amperes	0·99	0·73	0·47	0·23	1·30	0·99	0·77	0·53	0·99	0·94	1·24	1·09
Maximum elongation in scale divisions	Scale divisions	2	1·5	0·5	...	10	6	4	1	2·5	2·5	6·5	4·5
Retraction with current of 1·6 ampere	Scale divisions	6	9·5	11	11	9	15	18	20	11	11	8	11

The magnetic field at the centre of the coil = current × 92.
One scale division = one five-millionth part of the length of the wire.

maximum elongation), so that the retraction which is found to occur in all iron rods when a sufficient magnetising force is employed, is observed with smaller magnetising currents when the rod is stretched than when it is free, but want of suitable apparatus prevented him from submitting this idea to the test of direct experiment.

He has lately modified the instrument, which was described in his former paper, in such a manner that it can be used for observing the effects of magnetisation upon rods and wires under traction, and the results of a series of experiments made with it are presented in a synoptical form in the above table. Four specimens of iron were used. The first was a wire of commercial iron, 1·2 mm. in diameter, which had been softened by heating in a gas flame; the second was a strip of annealed charcoal iron, 5·5 mm. wide and 0·55 mm. thick, its sectional area being about 3 mm.; the third was a piece of hard unannealed wire, 2·6 mm. in diameter; and the last was a wire of very pure soft iron, 3·25 mm. in diameter, which had been carefully annealed. These were successively fixed in the apparatus, and loaded with weights varying from 3 lbs. to 14 lbs. While under the influence of each load, four observations were made in the case of each wire:—(1) A determination was attempted of the smallest magnetising current which sensibly affected the length of the wire in the direction of elongation or retraction. (2) The current producing *maximum* elongation (if any) and the extent of such maximum elongation were found. (3) A determination was made of the critical current which was without effect upon the original length of the wire, *i.e.* the current of such strength that a weaker one would cause elongation and a stronger one retraction. (4) The retraction produced by a fixed current of 1·6 ampere was measured.

The figures recorded in the table disclose the following facts:—

(1) The effects produced by magnetisation upon the length of an iron wire stretched by a weight are in general of the same character as those which have been shown in the former paper to occur in the case of a free iron rod. Under the influence of a gradually increasing magnetising force such a wire is at first elongated (unless the load be very great), then it returns to its original length, and finally it contracts.

(2) The maximum elongation diminishes as the load increases according to a law which seems to vary with different qualities of iron. If the ratio of the weight to the sectional area of the wire exceeds a certain limit, the maximum elongation (if any) is so small that the instrument fails to detect it.

(3) The retraction due to a given magnetising force is greater with heavy than with light loads.

(4) Both maximum elongation and neutrality (*i.e.* absence of both elongation and retraction) occur with smaller magnetising currents when the load is heavy than when it is light; retraction, therefore, begins at an earlier stage. Thus the anticipation expressed in the author's former paper is justified.

(5) The phenomena, both of elongation and of retraction are, as might be expected, greater for thin than for thick wires, and for soft than for hard iron.

Linnean Society, April 15.—W. T. Thiselton Dyer, C.M.G., Vice-President, in the chair.—The following gentlemen were nominated auditors, viz., J. Jenner Weir and F. Victor Dickins, as representing the Fellows, and Thos. Christy and F. B. Forbes for the Council; afterwards Mr. Rochfort Connor was elected a Fellow of the Society.—Specimens of so-called Madrepore marble from Iowa (U.S.) were exhibited for Mr. G. A. Treadwell. These contained abundance of a species of *Stromatopora*.—Mr. E. A. Heath showed living examples of *Dendrobium densiflorum* and *D. suavissimum*, and Mr. J. G. Baker drawings of new and remarkable ferns in illustration of the Roraima report.—A paper was read on new African genera and species of Curculionidæ by Mr. F. P. Pascoe. These were obtained from Mamboia, a missionary station north of Lake Nyassa, from Landana, a new settlement on the Congo, and Mayotte, one of the Comoro Islands off Madagascar. The author remarks that the inadequate descriptions, without reference to affinities or diagnostic characters as given by some entomologists, ought to be disapproved. The great diversity of appearance among the same genus of Curculionidæ is somewhat remarkable; secondary characters, therefore, have to be taken into account, but these, after all, may be quite as natural. On the other hand, species quite like each other in appearance are found to belong to widely different groups. For these and other reasons the correlation of stable characters is perplexing, and definite classification difficult.—The third part of Mr. C. E. Broome's series of fungi from Brisbane, Queensland, was read in abstract.—Mr. Everard F. im Thurn then gave the gist of a long report on the plants collected by him during his recent ascent of Mount Roraima, British Guiana. Among these, 3 new genera and 54 new species had been determined. The country of Guiana was described by him as consisting of three marked ascents from the Atlantic on the east to the central table-land west. The groups of vast sandstone columns, of which Roraima is the best known, really abut or overlap on to Brazil territory, and from their summit pour down

streams which flow in diverse directions to feed the rivers Orinoco, Essequibo, and Amazon. Roraima is therefore a probable centre whence peculiar vegetable forms may have originated and distributed themselves over a wide area. Regarding the flora of Guiana as a whole, three distinct zones of vegetation may be distinguished: one, the cultivated strip of coast-land; another, the forest which clothes the upward slopes of the country; and, third, the high savannahs of the interior. Within each of these zones plant species are evenly distributed, though occasionally on the savannahs uniformity is interrupted by small tracts of peculiar vegetation. Sometimes these tracts are marked by the occurrence of only one peculiar species—"areas of localised species"; sometimes by a large number of peculiar species—"areas of distinct vegetation." These latter have notable representatives in the savannah above Karctem Fall and Roraima itself; where, so to say, the more common plant species are excluded. This, then, gives them quite a separate and independent botanical facies.

Entomological Society, April 7.—Mr. Robert McLachlan, F.R.S., President, in the chair.—The following were elected Fellows:—Dr. Capron, Dr. J. W. Ellis, Messrs. F. D. Wheeler, M.A., J. B. Bridgman, F.L.S., T. D. Gibson-Carmichael, F.L.S., J. Rhodes, F.R.M.S., A. C. Horner, J. T. Harris, Evan John, Martin Jacoby, J. A. Clark, G. Elisha, and A. S. Olliff.—Mr. Crowley exhibited a large number of *Lepidoptera* from Accra, West Africa, including long series of *Charaxes* and *Rhomalæosoma*, and a number of specimens of *Saturnia* from Natal.—The Rev. W. W. Fowler exhibited four beetles belonging to the family *Carabidæ*. Three of them had been taken twenty years ago on the banks of the Clyde, and had lately been identified as *Anchomenus sahlbergi*, a species new to Europe, having hitherto been only found in Siberia. The remaining specimen was *Anchomenus archangelicus*, a North European species, nearly related to *A. sahlbergi*.—Mr. J. W. Slater exhibited a spider belonging to the genus *Galeodes*, a Lamellicorn beetle belonging to the genus *Cetonia*, and an undetermined species of *Curculionidæ*, all from Port Elizabeth, South Africa.—Mr. Billups exhibited a specimen of *Bassus bizonarius*, an Ichneumon new to Britain, taken at Peckham in 1885; also a series of another parasite, *Dimeris mira*, taken in Headley Lane, Surrey, in March last.—Mr. White exhibited preserved larvæ of two species of *Catocala*, for the purpose of calling attention to some hitherto undetected processes on the under side; and Prof. Meldola and Mr. J. J. Weir made some remarks on them.—Mr. H. Goss exhibited two remarkable varieties of the male of *Argynnis paphia*, taken in Sussex and Hampshire respectively.—Mr. S. Edwards exhibited an unknown exotic spider found in his Orchid House at Blackheath.—Mr. A. G. Butler communicated a paper entitled "Descriptions and Remarks upon Five New Noctuid Moths from Japan."—The Rev. W. W. Fowler read a paper on new genera and species of *Languriidæ*, chiefly from specimens in the collections of the British Museum, the Cambridge Museum, Mr. G. Lewis, and the Rev. H. S. Gorham; and Dr. Sharp and Mr. Champion made remarks thereon.—Dr. Sharp read a paper on "Some Proposed Transfers of Generic Names," the subject of a pamphlet recently published by M. Des Gozis, in which that author transposed many of the most familiar generic names. Dr. Sharp pointed out the extreme confusion caused by this practice, and showed that the theory on which the system was based was as unsound as the practice itself was objectionable. A long discussion ensued, in which Mr. Fowler, Mr. Waterhouse, Mr. Pascoe, Mr. McLachlan, Dr. Sharp, and Mr. Dunning took part. The last-named gentleman said that the discussion reminded him of a similar one on the application of the law of priority, which took place at a meeting of the Society nearly twenty years ago. The project was then condemned as unanimously as that of M. Des Gozis had been that evening, and he trusted that entomologists would hear no more of it.

Anthropological Institute, April 13.—Prof. A. H. Keane, Vice-President, in the chair.—Mr. H. Ling Roth read a paper on the origin of agriculture. He commenced by briefly reviewing the ideas entertained by savages as to the origin of agriculture among them; then, criticising the views held by scientific men of the present day on the subject, he discussed the conditions generally accepted as necessary to be fulfilled wherever agriculture is to flourish. He laid special stress on the fact that with savages the want of food could not possibly be an inducement to cultivate the soil, but considered that, from the social condition of women in barbarous life and their connection with the soil, they probably originated the first steps which ultimately led whole nations to become agriculturists. He then described what he thought might have been the first step, the rotation in which plants became domesticated, the three homes of agriculture and its spread amongst the uncivilised, and wound up with a few words on the development of agricultural implements.—A paper on the Sengirese, by Dr. Hickson, was read.—The election of Mr. Abraham Hale was announced.

PARIS

Academy of Sciences, April 12.—M. Jurien de la Gravière, President, in the chair.—Complementary note on the results of the application of the prophylactic method against rabies after the bite, by M. L. Pasteur. As many as 726 patients from every part of Europe, and even from North America and Brazil, have now been treated, of whom 688 were for dog-bite and 38 for wolf-bite. Of the first class all are doing well except the already-reported case of the girl Pelletier, and over half of the number have passed the critical period. Of the second class—all Russians—three have succumbed, the others, so far, progressing favourably. An essential difference is pointed out between the nature of bites by wolves and dogs, the former being regarded in Russia as always absolutely fatal. Hence the proportion of victims under the new process must be considered extremely low, more especially considering the severity of the wounds and the long time that elapsed before the treatment could be applied.—On the origin of the electric discharge in thunderstorms, by M. Daniel Colladon. The paper contains a more detailed statement of the author's views, already reported in previous numbers of the *Comptes rendus*, supplemented with remarks suggested by two violent thunderstorms observed by him in the Swiss Alps during the summer of 1885. In the latter an important feature was the *stationary* character of the thunder-clouds, inexplicable according to M. Faye's well-known theory.—Remarks on the second volume of the "Cours de Machines" presented to the Academy by M. Haton de la Goupillière. This volume treats of hydraulics and all kinds of hydraulic machinery, with a special chapter on accumulators and their various applications.—Note on a photographic map of the Pleiades group, by MM. Paul and Prosper Henry. This chart is an engraved reproduction of a proof on paper of the impression obtained on November 16, 1885, by means of the 0·33m. photographic equatorial twice enlarged. It shows, besides the interesting nebula near Maia, another near Electra, of which a very faint impression was obtained. It also indicates the existence of several new companions to Merope, Alcyon, and some other brilliant stars. The discrepancies between this map and Wolf's tables are most pronounced in the case of the small stars in the vicinity of brighter constellations. One of the 10th magnitude in Wolf's list is resolved in the photographic into two of the 13th magnitude. It is also pointed out that where direct observation gives only 625, the photographic process reveals 1421 stars in a somewhat smaller space.—On some remarkable spectroscopic phenomena, by M. A. Riccò. While recently observing on a very bright protuberance the inversion of the sodium rays D and D_2, the author was surprised to notice that the very vivid chromospheric ray D_3 seemed double, being divided by a very fine black line. The same effect was afterwards observed on the chromospheric rays C and F, and it is suggested that these and other double inversions noticed from time to time on the sodium and magnesium rays may be connected with the phenomenon of diffraction.—On the origin of M. Janssen's "solar photospheric network," by M. G. M. Stanoiewitch. From his studies of the photosphere the author concludes that, whatever be the origin of the solar granules, the "photospheric network," as presented by the photographic plates, does not exist on the surface of the sun. It is produced by the irregular refraction of a transparent body with irregular molecular constitution interposed between the granular solar surface and the photographic objective. This irregular refraction is caused by the gaseous envelope of the sun, which, being agitated by currents in all directions, presents as a whole a body of extremely irregular molecular constitution. This view was not accepted by M. Janssen, who made some remarks after the paper was read.—On the equilibrium of a fluid mass in rotation, by M. Matthiessens. The author claims priority of discovery of the annular figures which M. Poincaré lately stated had first been observed by the English geometricians Tait and Thomson. He refers to a series of papers ranging from 1845 to 1883, in which he describes the two rings and discusses the whole theory of these forms and of the ellipsoidal figures.—On a general theorem

relating to the propagation of motion, by M. Hugoniot. The method employed by the author in studying the propagation of motion in fluids is here generalised and extended to all movements regulated by the same system of mathematical formulas.—On the thermo-electric properties of iodide of silver, phosphuret of zinc, sulphuret of tin, and some other chemical compounds, by M. G. Chaperon.—On the density and compressibility of gases and vapours, by M. Antoine. The compressibility of atmospheric air is shown to approach that of nitrogen, whence an important induction is drawn for the use of automatic torpedoes in marine warfare.—On the optical phenomenon known as simultaneous contrast, that is, the tendency to produce the sensation of a complementary colours in the neighbourhood of any coloured surface, by M. Aug. Charpentier. From his researches the author infers that this phenomenon of contrasting colours produced in a region not directly excited is simply a case of *induced colours* in the literal and figurative sense of the expression.—Transformation of the protochloride of chromium into a sesquichloride: molecular states of the oxides of chromium, by M. Recoura.—On monochloruretted vinylethylic ether, trichloruretted, pentachloruretted, and some other chloruretted ethers, by M. L. Godefroy. The first-mentioned of these ethers, discovered by the author, has enabled him to prepare six other ethers, some already known, some new, and forming two distinct series with almost opposite general characteristic properties.—A study of the isomeric naphthylphenylcarbonyls, by M. Rospendowski.—On the eleven genera of the land Lumbricus established by Kinberg, by M. Edm. Perrier. Most of these so-called genera are shown to be mere species, and all the genera known in the time of Kinberg, or down to the year 1872, are now reduced to four. To these are here added eleven others, making fifteen at present known.—On the food of turtles, by MM. G. Pouchet and J. de Guerne. Although usually supposed to be herbivorous, the stomach of some turtles captured in the Azores waters yielded remains of *Hyalæa tridentata*, *Lepas anatifera*, besides Medusæ and small fishes.—Note on the discovery of a Cenomanian deposit at Pech de Foix, containing *Pygaster truncatus*, *Rhynchonella grasiana*, and other fossils of the same epoch, by M. J. Roussel.—Experimental essay on the toxic properties of febrile urines, by M. V. Feltz.—Note on the project of a railway from the coast of Syria to the Persian Gulf, by M. A. Dumont. The projected Euphrates Valley scheme connecting the Mediterranean with the Persian Gulf is favourably discussed from the engineering and economic standpoints. This alternative overland route is declared to be a necessity in the near future, in consequence of the continually increasing traffic through the Suez Canal. At the conclusion of the paper M. de Lesseps also spoke in favour of the scheme, which might be carried out for about 10,000,000*l*.

GOTTINGEN

Royal Society of Sciences, Aug. 1, 1885.—On the theory of liquid jets, by W. Voigt.—The spectrum of the brush discharge, by E. Hoppe. The lines showed a certain correspondence to those of aurora.—On the pyro-electricity of tourmaline, by E. Riecke. The method was to heat a tourmaline a given time in a space of high constant temperature, then hang it by a cocoon fibre to cool near the knob of a gold-leaf electroscope, whose behaviour was then noted. In cooling, the maximum of electric charge occurs if the tourmaline has first taken throughout the temperature of the heating space. The charge corresponding to a regular heating is nearly the same as that with an irregular, if the mean temperature of the latter be equal to the constant temperature of the former.—On Crinoids, by H. von Könen.

November 7.—On a representation of elliptic modulus functions, by infinite products, by H. von Mangoldt.—On Maccullagh's theory of total reflection for isotropic and anisotropic media, by P. Volckmann.

STOCKHOLM

Academy of Science, March 12.—Report on a visit to the Continent for the study and research of chemicals, by Dr. J. M. Lovén.—On Biunclearia, a new genus of Confervaceæ, by Prof. Wittrock.—On *Erythræa exsiccata*, V. B. Wittrock.—Report on a visit to the province of Jemtland (Sweden) for the prosecution of mycological studies, by Herr C. J. Johansson.—Report on a visit to the province of Scania for the prosecution of bryological studies, by Dr. A. L. Gröuvall.—On the formation of zoospores and quiescent spores in some species of the genus Conferva, by G. Lagerheim.—On the "Herbarium Ruborum Scandinaviæ" of Dr. C. J. Lindeberg, by Prof. Wittrock.—Report on a visit to Ireland, the North of France, Holland, and Westphalia, in order to study the Cretaceous formations of these countries, by Dr. J. C. Moberg.—On a discussion with a view to prove the stability of the planetary system, by Prof. H. Gyldèn.—Sur une formule dans la théorie des fonctions, by Prof. Pincherlè of Bologna.—Annotations on the mathematician Petrus de Dacia, and on writings (third part), by Dr. G. Eneström.—On a geological map of Scandinavia, Denmark, and Finland, exhibited and commented upon by Prof. O. Forell.—On the classification of tourmaline with the group of the rhombohedric tetartohedric forms of the hexagonal system, by Dr. W. Ramsay.

BOOKS AND PAMPHLETS RECEIVED

"The Fresh-water Fishes of Europe," by H. G. Seeley (Cassell).—"Traité de la Détermination des Orbites des Comètes et des Planètes," by A. Oppolzer (Gauthier-Villars).—"Templeton's Workshop Companion," enlarged by Hutton (Lockwood).—"Report of the Mitchell Library, Glasgow, 1885" (Anderson).—"Il Grande Ipnotismo," by Dr. G. Campili (Bocco, Turin.)—"Sound, Light, and Heat," by C. Bird (Relfe).—"Gardens of Light and Shade" (Stock).—"Encyclopædia Britannica," vol. xx. (Black).—"On Asthma," by Dr. H. Dobell (Smith, Elder, and Co.).—"Journal of the Royal Microscopical Society," April (Williams and Norgate).—"Mechanics and Faith," by C. T. Porter (Putnam).—"Systematische Übersicht der Fossilen Myriopoden Arachnoideen und Insekten" i. Abth., Bd. ii., by S. Scudder (München).—"Journal of the Society of Telegraph-Engineers and Electricians," vol. xv. No. 60 (Spon).—"Verhandlungen der Naturhistorischen Vereines," second year, part 2 (Max Cohen, Bonn).—"The Auk," April (Foster, New York).—"Journal of the Asiatic Society of Bengal," vol liv. part 2, No. 3, 1885 (Calcutta).—"American Museum of Natural History," Annual Report of the Trustees, &c., for the Year 1885-86 (Martin, N.Y.).—"Johns Hopkins University: Studies from the Biological Laboratory," vol. iii. No. v.—"The Influence of Sewerage and Water Supply on the Death Rate in Cities," by E. T. Smith.—"What is Materialism," by L. Stephen (E. W. Allen).—"Charles Darwin," by H. W. S. Worsley-Benison (Seers, Bath).—"Les Orages au Sud de la Russia," by A. Klossovsky (Odessa).

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